The Dissertation Committee for Sara Jolly Jones Certifies that this is the approved version of the following dissertation:

Teachers' Experiences in a Technology-Infused Lesson Study Professional Development

Committee:

Marilla Svinicki, Co-Supervisor

Joan Hughes, Co-Supervisor

Edmund Emmer

Diane Schallert

Daniel Robinson

Teachers' Experiences in a Technology-Infused Lesson Study Professional Development

by

Sara Jolly Jones, B.A.; M.A.

Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

May 2012

Dedication

For my nephews, Brandon and Hunter.
May you always have great teachers.

Acknowledgements

Many people have helped to make this dissertation possible. All of these people have contributed not only to this research project, but also to my growth as an educational researcher. I will always be indebted to them.

I was lucky to have not one, but two co-advisors, Dr. Marilla Svinicki and Dr. Joan Hughes, during this process. Both of these women have graciously supported me throughout graduate school and the writing of this dissertation. Upon entering graduate school, Dr. Svinicki immediately offered me her guidance. Since then, I have spent countless hours meeting with her about my studies, research, and general life issues. She is devoted to the learning and growth of her students and generously opened her schedule to help me along the way. Her support and constant encouragement gave me confidence to complete this dissertation. Dr. Hughes willingly opened her research teams to me even though I am not a student in her department. I cannot express how thankful I am for that opportunity. Her mentorship provided me with the knowledge base and skills necessary for envisioning and carrying out this research project. She introduced me to new fields of literature, and this dissertation is substantially better due to her feedback and suggestions.

My committee members, Dr. Daniel Robinson, Dr. Diane Schallert, and Dr. Edmund Emmer, also helped to shape this research project. I would like to thank Dr. Robinson for his sound and candid advice throughout my graduate career. He always pushed me to pursue rigorous research and to make meaningful contributions to the field. In my career, I will strive to meet the high expectations that he has set. Dr. Schallert's upbeat nature and dedication to her students make her a delight. Her love of learning is

contagious, and I hope to convey that same enthusiasm to my students in the future. Dr. Schallert's thought-provoking questions were immensely valuable as I wrote the final chapters of my dissertation. Dr. Emmer's instruction on qualitative methodology helped to give my research rigor. I also want to thank him for his careful reading and feedback on my paper.

I offer a very special thanks to the principal and teachers at Openwood Elementary School. They welcomed me into their school. Their honesty and unguarded participation were instrumental in making this research possible.

I also express my gratitude to Jacquelyn Hedden for organizing a dissertation writing group in Houston. Jacquelyn's diligence about coordinating and scheduling meetings has pushed me in my writing progress. I also want to thank Maria Biledith Benzon and Kathy Fellers, who helped to keep me accountable during the process.

Finally, I want to acknowledge all of the love, prayers, and moral support that I received from my family and friends. It would be impossible to mention all of these extraordinary people by name, but I do want to thank Gabe, my incredibly handsome husband (he made me say that) whose love and support allowed me to maintain my sanity these past few years and my parents who have always supported me in pursuing my dreams. Also a special recognition goes to the new Drs. Jane Vogler and Laura Torres. These ladies have made graduate school not only bearable, but lots of fun. I am honored to call them my friends and colleagues.

Teachers' Experiences in a Technology-Infused Lesson Study Professional Development

Sara Jolly Jones, Ph.D.

The University of Texas at Austin, 2012

Supervisors: Joan Hughes, Marilla Svinicki

Lesson study professional development, LSPD, is a technique during which teachers work collaboratively to create, implement, revise, and reflect on a specific lesson (Fernandez, 2002). This research proposed that using LSPD on integrating technology into teaching would provide teachers a collaborative and safe way to explore technology use in their classrooms.

Technology adoption is not a single occurrence, but a process that takes time (Fullan, 2007; Roger, 2003). Unlike traditional forms of training, LSPD provides sustained support and a way to test technologies in low stakes situations through collaboration and observation. Both of these aspects, experimentation and observation, are important in the adoption of technology (Rogers, 2003).

This study was aimed at understanding how teachers in a technology-infused LSPD change their beliefs and practices over time. Research questions included the following: a) how would teachers in a technology-infused LSPD develop their attitudes toward technology and in their technological pedagogical content knowledge (TPACK)?, b) how would teachers in a technology-infused LSPD change their lesson planning and teaching behaviors?, and c) would certain features of the group play a role in the teachers' development?

To address these questions, the study took qualitative approach to understanding teachers' experiences during the lesson study process. Using interview transcripts, lesson plans, group meeting transcripts, and field notes, group cases were compiled to examine the experiences of the groups. Although three groups of teachers were followed during the semester, only one team was able to plan, teach, and re-teach a lesson.

The LSPD process was disrupted by several factors independent of the lesson study model and more related to mandated testing and its results at the individual school level. The focus of the study shifted to describing the factors that contributed to and interfered with the carefully planned professional development model. The findings in this study can help us better understand the impact and intricacies of LSPD.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

As the amount of technology available in schools increases, teachers are faced with the pressure to integrate technology in meaningful ways. In this study, technology will refer to all electronic devices, with a focus mainly on computers. Ninety-seven percent of teachers in the United States had at least one computer in their classroom in 2009 (Gray, Thomas, Lewis, & Tice, 2009). In addition, over half of the teachers had the ability to bring extra computers into the classroom when necessary for instruction (Gray et al.). However, a third of teachers still reported "never" or "rarely" using technology often in their teaching, and there was a wide variety in the ways that technology was being integrated (Gray et al., 2009). Most recently there has been a call for technology integration that focuses on student use of technological tools in constructivist and socio-constructivists ways to support subject matter learning (ISTE, 2007, 2008, 2009; Partnership for 21st Century Skills, 2009; National Educational Technology Plan, 2010). Eteokleous (2008, p.673) refers to this shift in focus as "learning with computers" rather than "from computers" and calls it transformative technology use.

Over the past few decades, a number of different types of professional development have been used to help teachers use technology in the classroom, but not all of these types have supported transformative technology integration in schools. These approaches include providing technological equipment without any training, instructing teachers on affordances and constraints of technology, building technology according to specific pedagogical theories, and teacher education courses (Cuban, 1986; Harris,

Mishra, & Koehler, 2009). Most of these methods are technology-centered, rather than teacher- or student- centered.

Although technology professional development is changing, it is still heavily workshop based and tends to use the information processing approach of lecturing. This type of professional development has not resulted in much change in instructional practices or student achievement (Cuban, 1986; Macmillan, Liu, & Timmons, 1997; McCannon & Crews, 2000). One possible reason is a mismatch between the training, the teacher's own attitudes, and the way teachers implemented technology use. Evidence shows that teachers' beliefs strongly influence their use of technology (Ertmer, 1999; Niess, 2005; Ravitz, Becker, & Wong, 2000; Sang, Valcke, von Braak, & Tondeur, 2010). Niess (2006) calls for professional development that "recognize[s] and emanate[s] from the teacher's experiences and provide[s] them with extended experiences in teaching [their subject matter] with technology" (p. 198). To address this lack of teacher and learning focus in professional development, Mishra and Kohler (2006) developed the concept of Technological Pedagogical Content Knowledge, (TPACK), as a way to describe the knowledge that teachers need in order to integrate technology effectively in their instruction. They emphasized understanding the interactions between technology, content, and pedagogy, rather than knowledge of each of the domains independently.

The TPACK framework is structured after Shulman's (1986) idea of pedagogical content knowledge which asserts that in order to be an effective teacher, one cannot rely on separate knowledge of content and pedagogy, but must also have an awareness of the ways pedagogy can be used to support learning of specific content. In the same way,

TPACK represents the intersections between the three major knowledge domains of technology, pedagogy, and content creating seven knowledge domains: Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK) (Koehler & Mishra, 2005a). Figure 1 shows the seven domains and their relationships to each other. Technological Pedagogical Content Knowledge (TPACK) forms the core of the TPACK framework integrating technology, content, and pedagogy. Knowledge in this domain involves recognizing how technological tools, subject matter, and pedagogical techniques can work to augment or hinder one another. The interrelatedness of the three domains is the main focus and the goal for the TPACK framework. According to the model, teachers use technology most effectively when they are able to plan their technology integration while simultaneously considering the content, pedagogy, and technology pieces of instruction (Niess, 2005). It is important to remember that TPACK knowledge is not proficiency in each of the three main domains separately, but the ability to realize and appreciate the connections between those three domains. Because of this, simply gaining knowledge in one knowledge area does not automatically increase a teacher's TPACK (Angeli & Valanides, 2005; Valanides & Angeli, 2008a, 2008b).

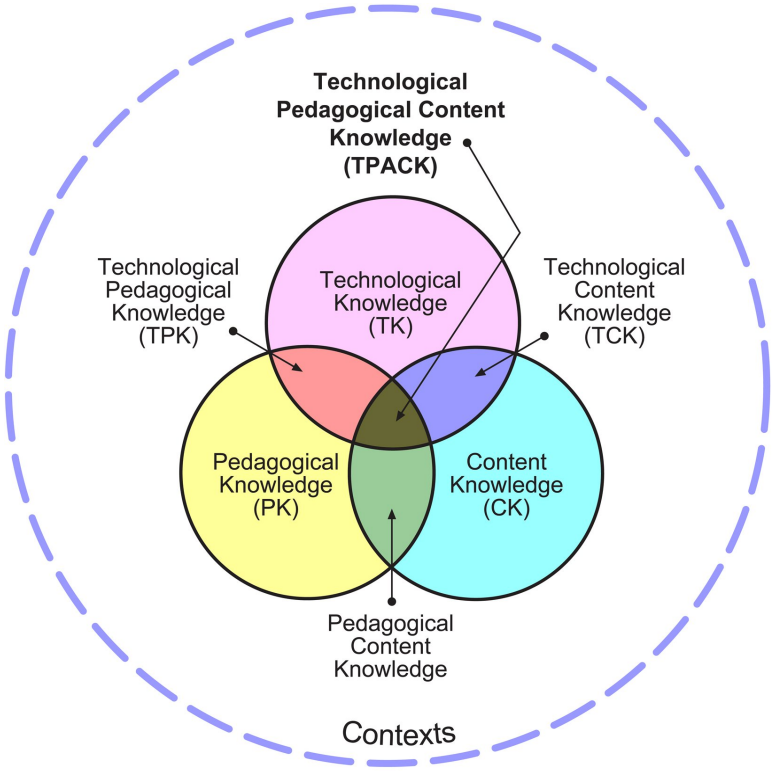


Figure 1: Technological Pedagogical Content Knowledge [*http://tpack. org/*](http://tpack.org/)

Starting originally in university teacher training courses, two main strategies have been adopted to increase teacher's TPACK: activity types based training and design-based learning (Harris & Hofer, 2011; Harris, Mishra, & Koehler, 2009; Koehler & Mishra, 2005a; Tee & Lee, 2011). Activity types training uses a social cognitive approach to teacher training that focuses on modeling technology use in content specific activities (Harris & Hofer, 2011; Harris, Mishra, & Koehler, 2009). In activity types training, core subjects are divided into specific activities that frequently occur in the teaching and learning of a particular subject. For example, read text material, solve a computation, interpret a graphical representation, and generate a problem are all mathematics activity types. These activities can be strung together to create a math

lesson (Grandgenett, Harris & Hofer, 2011). Activity type training is based on research that teachers plan by combining and sequencing "routinized activities" rather than starting from scratch with each lesson (Tubin & Edri, 2004; Yinger, 1979). Once a list of activities is created for a given subject, technologies are integrated into those activity types so that the technology component becomes essential to the activity rather than an added on activity. These lists of technology-integrated activity types were constructed over a period of time with the help of several content matter experts and are still being updated as teachers work together to create more comprehensive lists for all core subject areas (Harris, Mishra, & Koehler, 2009). In activity type training, it is these technology-rich activities that are taught and modeled to pre-service and in-service teachers. This training accomplishes the goals of integrating technology, content, and pedagogy, but often occurs in the university setting removed from a K-12 classroom. This distance can cause a divide between the teacher learning and the actual teaching. There is often no support once the teachers return to their own classes. Another problem with this type of training is that the structured activity-types may not leave room for adaptation of the activities once the teachers are back in their home schools.

Design-based trainings eliminate this issue of adaptation by having the teachers design their own lessons or course as a main component of the professional development. The underlying explanation is that using a sustained socio-constructivist approach to professional development will lead teachers to shift their understanding and see technology integrated in their teaching. Learning Technology by Design (Koehler & Mishra, 2005a, 2005b; Koehler, Mishra, & Yahya, 2007) is a technique used in teacher

technology courses to facilitate technology integration in the classroom. Others have used alterations to this approach with inservice teachers (Angeli & Valanides, 2009; Tee & Lee, 2011). The approach "is a constructivist approach that sees knowing as being situated in action and co-determined by individual-environment interactions" (Koehler & Mishra, 2005a, p. 134). In one study, technology graduate student groups were paired with education faculty to develop new online education courses. The masters level course provided technology design students with a real-world problem and faculty with technology support to transition to an online learning environment. Students and faculty met weekly throughout the semester to create the online courses. End of the semester surveys showed that students' beliefs about technology integration were significantly different than the beginning of the semester (Koehler & Mishra, 2005a). By then, the students recognized that the teaching and designing of an online course was different than a face- to- face class, and required a change in their teaching methods.

Despite this change in the students' beliefs, there are several limitations to this type of training. Using this technique, teachers receive little to no modeling of the technology in a teaching context, but rather are thrown directly into thinking about how they can incorporate the technology into their teaching. Additionally, this type of professional development is also concentrated at the university level. Pre-service teachers may not know enough about their future teaching context to successfully develop a technology lesson they will be able to implement. In-service teachers may be able to design the lesson, but without modeling or support, once they return to their classroom, they may have difficulty anticipating issues and implementing their lessons.

A technology-infused lesson-study professional development is a third option for helping teachers learn to integrate technology in their classrooms. Lesson study professional development originated in Japan, and has been used mainly in mathematics in the United States (Lewis, 2002). In lesson study professional development, teachers plan, implement, and revise a "research lesson" (Fernandez, 2002; Lewis, 2002). This lesson is referred to as a "research lesson" because it is intended to be a lesson that teachers would like to improve upon, and in the lesson study process, teachers take an action research approach to accomplish that goal. Teachers first meet in a small group to write a detailed lesson plan centered on an area where students are weak or an objective that is particularly critical to the curriculum. This lesson plan includes not only what the teacher in the classroom will do, but also how the teachers expect students to respond through the lesson. Once the plan is created, one teacher volunteers to teach the lesson with his or her students. The other teachers observe the lesson with a focus on the student reactions and learning that occur during the lesson. This modeling component allows teachers to experience the lesson within their own school. After the model lesson, the teachers reflect on their experiences and observation of students to revise the lesson plan. If the lesson changes drastically, another model lesson should occur. When everyone is satisfied with the lesson, all of the teachers use the lesson plan in their own class. Finally, the teachers write a reflective report that chronicles their goals, the lesson plan, and what they learned in the process of the lesson study. These reports are shared within the school and district with the goal of building a library of model lessons (Fernandez, 2002; Lewis, 2002).

The lesson study approach does not traditionally contain a technology focus, but a few researchers have started to use technology in the lesson study process (Calvin, 2008; Chai, Koh, & Tsai, 2010; Groth, Spickler, Bergner, & Bardzell, 2009). In these studies, the "research lessons" include a technology component in order to push teachers both to design and to reflect on a lesson that includes technology, and have shown success in changing teachers' attitudes toward technology use in the classroom. Unlike the workshops, activity-type training, and learning by design, lesson study includes the designing of a lesson, modeling of technology use, and a reflective component. These three aspects, along with situated and sustained support within the school, should be successful in helping teachers adopt technology into their teaching.

Statement of Problem

As the use of technology outside of the school grows, the push for technology integration in schools is also increasing. Many advances have been made in pre-service teacher training, but there still is a need for more effective technology professional development for in-service teachers. The study was aimed at understanding the experiences of teachers in a technology-infused lesson study professional development environment.

This study investigated the following questions about a technology-infused lesson study professional development in a public elementary school conducted during one semester:

1. How do teachers in a technology-infused lesson study group develop (a) their attitudes toward technology and (b) their technological pedagogical content knowledge (TPACK)?
2. How do teachers in a technology-infused lesson study group change their lesson planning and teaching behaviors?
3. Do certain features of the group (such as membership, grade level, subject matter, group interactions, etc.) play a role in the teachers' development?

In this dissertation, I used group case studies (Bogdan & Biklen, 2003; Saldana, Leavy, & Beretvas, 2011; Yin, 2009) to understand lesson study professional development. This qualitative approach allowed me to explore if, how, and why lesson study professional development can help teachers integrate technology, and the factors that lead to successful completion of lesson study professional development.

Chapter 2: Literature Review

Technology Integration

Researchers often use the term *technology integration* without clearly defining the construct. In the past technology integration in schools was judged by the number of computers in the school or teacher use of technology in schools (Cuban, 1896). Later studies included student use of technology in the definition of technology integration (Gray, Thomas, Lewis, & Tice, 2009; Russell, Bebell, O'Dwyer, & O'Connor, 2003). Eteokleous (2008) further distinguished student use of technology into two categories: *traditional* and *transformative*. The *traditional* view of technology integration is characterized as "learning about computers" and "learning from computers (Eteokleous, 2008, p. 673). "Learning about computers" includes activities that are either specifically directed at increasing the students' computer skills, while "learning from computers" refers to computer-assisted learning and drill and practice programs designed to teach students core subject matter. *Transformative* technology integration is a shift to "learning with computers" (Eteokleous, 2008, p. 673). "Learning with computers" is different than "learning from computers" because the students "do not learn from technology, but [the] technologies support meaning generated by students" (Eteokleous, 2008, p. 673). Recent calls push for a more transformative technology integration (ISTE, 2007, 2008, 2009; National Educational Technology Plan, 2010; Partnership for 21st Century Skills, 2009). In line with this movement, this research defines effective technology integration as the teacher and student use of computer technology in constructivist and socio-constructivist

ways to support the learning of core subject area content (Read, Jones, Hughes, & Gonzales-Dholakia, 2011).

In order for this type of transformative technology integration to occur, teachers need training that not only supports their own technology skills, but also aids in any pedagogical changes that the teachers need to make in their teaching. Ferdig (2006) discussed the importance of judging technology integration based on the context and the purpose of the innovation. Instructional technology must be evaluated with the educational objectives at the forefront. Ferdig (2006) also argued that because technology evaluation is context specific, the role of the teacher is important when assessing a technological innovation. He proposed technological pedagogical content knowledge as one way to assess a teacher's decisions about technology integration in the classroom.

Technological Pedagogical Content Knowledge (TPACK)

Mishra and Koehler (2006) developed the concept of Technological Pedagogical Content Knowledge (TPACK) which emphasizes the importance of teachers having an integrated understanding of how technology, content, and pedagogical methods work together to increase learning within their particular content discipline (Figure 1). The TPACK framework is structured after Shulman's (1986) idea of pedagogical content knowledge that asserts that in order to be an effective teacher, one must have more than a separate knowledge of content and pedagogy, but must also have an awareness of the ways pedagogy can be used to support teaching and learning of specific content. In the same way, TPACK represents the intersections between the three major knowledge

domains of technology, pedagogy, and content, creating seven knowledge domains: Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). See Figure 1 in the previous chapter for a complete depiction of these areas.

Content Knowledge

Content knowledge (CK) deals with the teacher's knowledge of the subject matter. Content knowledge includes understanding of the facts, concepts, and inquiry methods within the field. Because these can vary greatly according to subject and level, it is important that teachers are competent in the area that they are teaching.

Pedagogical Knowledge

Pedagogical knowledge (PK) is the understanding of the theories and principles related to teaching and learning. This knowledge domain includes understanding how to support student learning with a variety of methods. Although Mishra and Koehler (2006) focus only on pedagogical knowledge, there is a great deal of overlap between teacher's knowledge and beliefs about pedagogy (Kagan, 1992). Due the intertwined nature of pedagogical beliefs and knowledge, my research will not attempt to separate the teachers' knowledge from their beliefs.

Technological Knowledge

In the TPACK framework, technological knowledge (TK) refers to technology in the broad sense of the word including technology from blackboards to computers. The

skills necessary to install and operate digital technologies fall into this domain. Technology standards are also part of technological knowledge. Because the field of technology is rapidly changing, technological knowledge may be more unstable than either content or pedagogical knowledge. This domain is the focus of most technology tutorials and workshops.

Prior to the TPACK model, Margerum-Lays and Marx (2003) referred to this knowledge as content knowledge of educational technology. They argued that this knowledge "allows teachers to envision instances in which technology might be appropriately used in their teaching and to allow them to initiate those visions" (Margerum-Lays & Marx, 2003, p. 140). However, they also pointed out that there are differences between personal technology use and knowledge of technology for teaching and learning purposes. Because of this, a strong technological competence does not directly translate to increased technology integration in the classroom (Hughes, 2005). Newer teachers tend to have more exposure to technology but are not always able to transfer that knowledge into effective learning situations for their students (Hughes, 2005; Lee & Tsai 2007; Niess, 2005).

A teacher technology use survey conducted in 2002 (Russell, Bebell, O'Dwyer, & O'Connor, 2003) showed that whereas teachers with less than five years of experience reported feeling more confident with technology and using technology more for professional use outside the classroom, they were less likely than teachers with six to fifteen years to use technology during class time. New teachers may be lacking a strong understanding of pedagogical content knowledge, which prevents them from fully

integrating technology into the classroom despite having a strong technology knowledge base. Without a framework for effective teaching, newer teachers may not understand how to adapt their current technology knowledge into a teaching tool.

Pedagogical Content Knowledge

Initially proposed by Shulman (1986), pedagogical content knowledge (PCK) is the knowledge of how to teach information within a specific content area. A teacher's knowledge of the structure of their content and the misconceptions that learners may have about the subject is part of PCK. Another component of PCK is an understanding of which pedagogical strategies are most effective in addressing learner difficulties.

Technological Content Knowledge

The intersection between technology and content consists of the knowledge about how technology affects a specific content matter. Technology has changed the way that information is constructed or discovered in many fields. For example, computer programs now allow complicated mathematic calculations to be performed more quickly than ever. The advancements in technology have driven scientific discoveries and changed the way that many professionals work in the field. At the same time, content matter and established assumptions and knowledge structures guide the development of new technologies. Knowledge of this reciprocal interaction comprises the domain of technological content knowledge (TCK).

Technological Pedagogical Knowledge

Just as content and technology interact and change each other, so do the domains of technology and pedagogy. Technological Pedagogical Knowledge (TPK) involves

understanding how technology can be used to support and enhance pedagogical strategies. Technological advancements have provided metaphors for human learning that shaped the evolution of educational theories. At the same time, theories about how people learn continue to direct the development of new technologies.

Technological Pedagogical Content Knowledge

Technological Pedagogical Content Knowledge (TPACK) forms the core of the TPACK framework integrating technology, content, and pedagogy. Knowledge in this domain involves recognizing how technological tools, subject matter, and pedagogical techniques can work together to augment or hinder one another. The interrelatedness of the three domains is the main focus and the goal for the TPACK framework. According to the model, teachers use technology most effectively when they are able to plan their technology integration while simultaneously considering the content, pedagogy, and technology pieces of instruction. It is important to remember that TPACK knowledge is not proficiency in each of the three main domains separately, but the ability to realize and appreciate the connections among those three domains. Because of this, simply gaining knowledge in one knowledge area does not automatically increase a teacher's TPACK (Angeli & Valanides, 2005; Valanides & Angeli, 2008a, 2008b).

Assessing Technological Pedagogical Content Knowledge

Because of the relatively new nature of technological pedagogical content knowledge, researchers are still trying to determine the best way to measure teachers' development within this construct. The majority of researchers use qualitative measures to give rich descriptions of teachers' TPACK and their knowledge development through

various types of technology professional development experiences (Hervey, 2010; Hughes, 2005; Koehler, Mishra, & Yahya, 2007; Niess, 2005; Niess et al., 2009; Richardson, 2009). Many of these studies focus on pre-service teachers or graduate level teacher programs in which researchers have prolonged access and multiple measures of the teachers' growth. Niess et al. (2009) proposed an iterative model of five TPACK developmental stages: recognizing, accepting, adapting, exploring, and advancing. Due to the varied and changing nature of technology, teachers can be in different stages of the continuum in regards to different technological tools. Although Niess et al. (2009) proposed a number of TPACK standards for mathematics teachers, no instrument has been developed to identify a teacher's stage in the TPACK development model.

More recently, attempts have been made to quantify and measure TPACK. During a graduate level educational design course, Koehler and Mishra (2005) surveyed faculty members and technology design graduate students about their perceptions of the course, their thoughts about online education, and their level of TPACK. The survey was administered four times during the semester to track changes and growth throughout the semester. Archambault and Crippen (2009) also created a self-report survey for online teachers to measure their TPACK. In 2009, Schmidt et al. validated a self-report TPACK scale for K-6 pre-service teachers. In this instrument, teachers rate their ability to teach various content areas and their understanding of technological tools. Despite the validation of these measures, they all rely on teacher self-report data rather than assessing knowledge of the seven components of TPACK or the actual integration of technology in the classroom.

Harris, Grandgenett, and Hofer (2010) proposed a rubric-based approach to assessing technology integration. Their rubric corresponds to the four technology-related knowledge areas in the TPACK framework: technology knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge. The rubric allows researchers and teacher educators to appraise actual technology integration in a lesson plan instead of relying on teacher self-report data. In addition, the rubric provides a model for evaluating TPACK in the context of multiple pedagogical orientations rather than regarding any specific educational theory over another. For this reason, I included this rubric as one of the measures for technology integration in this study.

The TPACK framework is typically measured and described as a knowledge framework (Archambault & Crippen, 2009; Mishra & Koehler, 2006; Schmidt et al, 2009). However, because knowledge and beliefs are so intertwined (Kagan, 1992), it is difficult to understand a teacher's TPACK without considering their beliefs about pedagogy, technology, and the subject matter taught. Additionally, because technology integration has been defined as *student use of technology in constructivist and socio-constructivist ways to support the learning of core subject area content*, the goal in my research is not simply to increase a teacher's pedagogical knowledge, but to change the teacher's beliefs about different pedagogical strategies. The school site involved in this study includes a Montessori program. I assumed that this paradigm and the teachers' experience with it would shape their TPACK. The next section describes the Montessori

nature of the research site to allow a better understanding of the significance of that aspect of the school's philosophy and its possible impact on teachers' development.

Montessori

The Montessori teaching method was developed in Italy by Maria Montessori. Montessori considered children as whole beings who were capable of learning without much interference from adults (Montessori, 1912). Under the Montessori paradigm, learning is guided by the child, rather than the teacher:

> Scientific observation has established that education is not what the teacher gives; education is a natural process spontaneously carried out by the human individual, and is acquired not by listening to words but by experiences upon the environment. The task of the teacher becomes that of preparing a series of motives of cultural activity, spread over a specially prepared environment, and then refraining from obtrusive interference. Human teachers can only help the great work that is being done, as servants help the master. Doing so, they will be witnesses to the unfolding of the human soul and to the rising of a New Man who will not be a victim of events, but will have the clarity of vision to direct and shape the future of human society. (Montessori, as cited in Faryardi, 2007, p. 3)

Montessori created specific sets of materials in order to engage students' senses and help facilitate their learning (Lilliard, 2008). These techniques and materials provide opportunities for students to interact with and construct meaning from their environment. All of this learning has to take place within the child's developmental range, similar to

Vygotsky's zone of proximal development (1978). Montessori outlined four phases or planes of child development (Monson, 2006):

1. First Plane (birth to 6)

   Children in this phase discover that they can do things on their own. Helping children accomplish tasks can hinder this discovery. Home and school are still very connected in children in this stage.

2. Second Plane (6 to 12)

   In this stage, home and school are separated. Children need a more structured environment with opportunity for social contact. The educational constructs become more abstract and involve concepts of equity, justice, fairness, and culture.

3. Third Plane (adolescence)

   Adolescence is characterized by vocation and militancy. At this age, students begin to want to make contributions to society and to have their contributions recognized.

4. Fourth Plane (adulthood)

   The fourth plane corresponds with adulthood and college level education.

Montessori classrooms are traditionally multiage classes that correspond to the developmental planes of students.

Montessori also felt that "the child should love everything he learns, for his mental and emotional growths are linked" (1989, p. 17). In order for this to occur, Montessori suggested that students be allowed to direct what activities they wish to

complete at any given time (Faryadi, 2007). Although autonomy is supported, a sense of personal responsibility for learning is also instilled in the children of a Montessori classroom (Faryadi, 2007).

In the traditional Montessori school, the only materials available to students were those created by Maria Montessori herself (Lilliard, 2008). These hands-on activities and puzzles were the basis for the entire curriculum for students. However, aligning completely with an authentic Montessori paradigm can be difficult for American public schools, and many schools make adaptations and additions to the materials created by Montessori (Lilliard, 2008; Monson, 2006). Although some feel that these changes may hurt the integrity of the paradigm (Lilliard, 2008), others argue that new materials and new technologies are needed because the original materials may not authentically reflect today's society (Hubbell, 2006). Because technology is now integrated into our daily lives, some are pushing for the integration of technology in Montessori classes as a way to provide more authentic and meaningful learning experiences (Hubbell, 2006; Love & Sikorski, 2000). However, little research has been done on the actual integration of technology in the Montessori classroom.

Because pedagogical knowledge and beliefs influence teachers' technology adoption (Ertmer, 2005; Fullan, 2003), teachers who hold strong Montessori beliefs will most likely integrate technology in ways that align with the Montessori paradigm. Teachers who have not been teaching under this paradigm may need more support to include technology in constructivist ways in their classes.

School and Teacher Change

Whether the teachers are teaching primarily with a traditional public school curriculum or a Montessori curriculum, teachers and the schools they work in will need to undergo substantial change in order to integrate technology into their classes. Fullan (2007) describes three dimensions of teacher change: a) the use of new teaching *materials*, b) the use of new *teaching strategies*, and c) a change in teaching *beliefs*. Without all three components, the change will not be sustainable, and teachers will revert to their original practices.

Change is a process that requires struggle, and teachers must be motivated to engage in the change process for it to be successful (Fullan, 2007). Fullan argues that developing teacher motivation is "fundamentally related to whether the teachers are likely to find the considerable energy required to transform the status quo" (2007, p. 39). One factor that can affect teacher motivation is the way that teachers view the relationship between autonomy and professionalism. Elmore (2004) proposes:

> Educators equate professionalism with autonomy- getting to use their own judgment, to exercise discretion, to determine the conditions of their own work in classrooms and schools. (2004, p.3)

Although Elmore feels that this mindset is problematic, understanding it exists is helpful when trying to implement changes in schools. Any new materials, ideas, or programs that threaten a teacher's sense of autonomy can reduce their motivation to accept the new innovation. In a literature synthesis, Leithwood (2005) found eight factors that contributed to teacher motivation:

1. Individual sense of professional efficiency
2. Collective sense of professional efficacy
3. Organizational commitment
4. Job satisfaction
5. Stress and burnout
6. Morale
7. Engagement or disengagement from the school and the profession
8. Pedagogical content knowledge (p.2)

While these factors relate to teachers' motivation in more general sense, rather than their motivation to change or improve, one can conclude that teachers who are not motivated to engage in regular teaching activities will not be motivated to participate in the additional effort for improvement and change.

Another factor that can affect the teacher change process is the number of simultaneous responsibilities that teachers are required to do. Fullan (2007) describes *innovation overload* as "the business of contending simultaneously with multiple innovations" (p. 68). Principals and other school leaders often serve as the gatekeepers to change in their schools. Fullan explains that "without quality internal leadership, you end up not with limited innovation, but rather its opposite- too many fragmented, uncoordinated, flavor-of-the-month changes" (2007, p.76).

Change in schools takes place in three phases: 1) initiation, 2) implantation, and 3) continuation (Fullan, 2007). During these three phrases an appropriate balanced must be maintained to propel the project forward without stifling the autonomy and motivation

of the teachers. Principals, teacher leaders, and change implementers should all work together to find ways to build accountability for the change while remaining flexible to alterations that to the initial change plan. One way to facilitate this open communication is through learning communities. Fullan (2007) argues that:

> The more you develop active professional learning communities within schools in which teachers observe one another's teaching, and work with school leadership to make ongoing improvements, the greater the consistency and quality of teaching across the whole school, at which point all students in the school benefit and keep on benefitting. (p.54)

He also admits that this is a difficult task. Fullan (2007) proposes three reasons that learning communities fail. First, there is a lack of commitment and support from policymakers. Secondly, teachers may undermine the collaborative nature of the learning community. Teachers "find privatization a lot less risky than opening the door of the classroom, even or especially to colleagues" (Fullan, 2007, p. 149). And finally, learning communities themselves require a cultural shift in the teaching profession.

Despite these obstacles, research has shown that this sustained dialogue is needed for long term teacher change and growth. The next section discusses the history and research on teacher professional development in general, before looking more specifically at technology professional development.

Teacher Professional Development

Almost all teachers are required to participate in professional development throughout the year, but these training experiences can vary drastically. Professional

development can be used to refer to an experience or activity in which a teacher engages in order to improve his or her teaching. These teacher learning experiences can range from workshops and online modules to mentoring and learning communities. Reviews of the professional development literature have confirmed that not all professional development is effective in improving teachers' knowledge, changing teachers' beliefs, and changing teachers' practices (Avalos, 2011; Birman, Desimone, Porter, & Garet, 2000; Guskey & Yoon, 2009; Hunzicker, 2010). In one review, Birman et al.(2000) provided a list of things to consider when planning professional development: form, duration, participation, content focus, active learning, and coherence. In her study, Hunzicker (2010) offered a condensed list of five characteristics of effective teacher professional development: supportive, job-embedded, instructionally-focused, collaborative, and ongoing. Despite the literature on effective teacher learning, many professional development opportunities do not meet these criteria.

Teachers have many responsibilities and only a limited time without students, so making time for professional development can be a challenge. For this reason, workshops are one of the most popular forms of professional development. In 2000, 94.8% of public school teachers reported participating in a workshop, conference, or training session as part of their professional development (Choy et al., 2006). Although workshops are the most frequently used form of professional development, they are also one of the most criticized because many are short, isolated events that may be unrelated to the teachers' daily work or to research-based practices of instruction. They may also

be more directive in teaching style with limited opportunity for teacher practice and active learning.

In a national survey of 1999-2000, 58.1% of principals reported that in-service trainings were frequently or always planned by teachers in the school (Corcoran et al., 2001). The study also found that although district staff felt strongly about professional development being research based, school personnel placed more importance on advice from other teachers and were ill-equipped to interpret scientific research or judge its significance. Rogers (2003) also stated that teachers tend to adopt new practices and technology when they are recommended by a colleague, rather than an outside agent. Even when the districts had staff development offices "the professional development staff members felt that their effectiveness would be judged by whether they could attract and please teachers, so when they had discretion over what to offer, they tended to focus on the hot topics of the day" (Corcoran et al., 2001, p. 82) rather than on empirically-based practices.

Teachers rated school district provided in-service trainings an average of 2.55 on an effectiveness Likert scale with 1 being "definitely not effective" and 4 being "definitely effective" (Smylie,1989). These trainings received the lowest score when compared to other forms of professional development such as consultation with other teachers, graduate and undergraduate courses, and independent research. Other professional workshops and conferences hosted outside the local school or district received a slightly higher rating of 3.05, suggesting that teachers view outside workshops as more effective than local level trainings (Smylie, 1989).

District level teacher professional development does not always meet the needs of the individual teachers. While 77% of principals reported that teachers had a great deal of influence over the professional development they received, only 33% of teachers responded they felt they had great influence (Choy et al., 2006). The principals did rank district initiatives, school improvement plans, and state and local academic and skill standards as more influential than teacher preferences. Of the three districts studied by Corcoran et al. (2001, p. 83), all districts decided the workshop content at a district level "generally neglected the content knowledge of teachers." If teachers do not perceive a need for change, they may have decreased motivation to apply the new information learned in professional development to their own teaching.

On the other hand, professional development that included some component of teacher follow-up showed a positive relationship with student achievement (Guskey & Yoon, 2009). This important element is missing in many workshop type trainings. Trainings often occur before the start of the school year or during in-service training days. Training days are isolated from the regular duties of the teacher and may be seen as completely separate activities. If this is the case, transfer to the classroom is difficult. Teachers are expected to continue developing their knowledge once they return to their classroom, but little to no support is offered to help them continue the learning process that is necessary to culminate in change in teaching practices (Fullan, 2007).

Social cognitive and socio-constructivist theories have led a push toward more collaboration amongst teachers. In 1999-2000, collaboration with other teachers was the second highest professional development option in terms of participation, with 74.4

percent of teachers reporting that they had been involved in regularly scheduled collaboration with other teachers (Choy et al., 2006). However only 38.1 percent of teachers "strongly agreed" to the statement "I make a conscious effort to coordinate the content of my course with other teachers" and slightly less (36.8 percent) strongly agreed that "There is a great deal of cooperative effort among the staff members." In an older study, consultation with others received an average rating of 3.46 on a 4-point effectiveness scale, ranking as less effective than learning from direct teaching experience, but more effective than all of the other professional learning opportunities for teachers (Smylie, 1989).

There are several ways that teachers can collaborate, including mentoring programs and learning communities. Mentoring is especially popular as a way to provide professional development to beginning teachers. In the national schools and staffing survey, 59. 6 percent of the teachers with 5 or fewer years of teaching experience worked closely with a master teacher or mentor during their first year (Choy et al., 2006). Unfortunately, of those that participated, only 36.6 percent rated their mentor as helpful, 4 or 5 on a 5 point scale (Choy et al., 2006). Mentors are often assigned without training or clear expectations as to their role. Another challenge with mentoring programs is that mentors are usually teachers who also have their own classes and teaching responsibilities. A mentee may be an added responsibility in an already full schedule.

The idea of a "learning community" is based around the notion that a school is a community of learners (Boyd & Hord, 1994; Fullan & Hargreaves, 1991). While there are many terms and definitions associated with learning communities (Copper & Boyd,

1995; Cotton, 1994; Fullan, 1993; Graves, 1992), they all center on the idea that a group of people have come together to engage in some learning or inquiry process in order to improve their teaching. In these groups learning is a collaborative process (Clausen et al., 2009). Graves (1992) defines a learning community as "an inherently cooperative, cohesive, and self reflective group entity whose members work…toward common goals while respecting a variety of perspectives, values, and life styles (p. 94).

In a case study of four teachers working together to improve literacy, Clausen et al. (2009) reported that while the participants started with a top-down view of the action research project, gradually they became engaged and also began to seek other colleagues for knowledge and expertise rather than the principal. One important component in developing learning communities is allowing teachers to have flexible time schedules in which to meet and work with the group (Clausen et al., 2009). Teachers' daily schedules are often very tight, so without explicit time set aside for collaborative planning, it may not be a priority. Another benefit of learning communities is that they provide ongoing resources for continued development (Clausen et al., 2009). One teacher reported that action research was the only professional development that she felt had increased her "level of professional understanding and performance" (Clausen et al, 2009, p. 450).

While learning communities are based in collaborative teacher efforts rather than a top down model of professional development, it is important that administrators structure the school environment so that these types of activities have the opportunity to develop and be sustained for continuous growth (Fullan, 2007). Without resources or support these programs could quickly fail.

Some theorists (Borko, 2004; Putnam & Borko, 2000) feel that learning through collaboration with others is not sufficient to transfer the knowledge gained to changes in classroom practices. From a situated cognition perspective, the context and all that entails is a fundamental component of learning (Borko, 2004; Greeno, 2003; Lave &Wagner, 1991). In other words, the collaboration among teachers must occur within the context that the teachers are teaching in in order to change teacher practices. Teachers rated actual classroom teaching experience an average of 3.91 out of 4 on effectiveness as a professional development opportunity (Smylie, 1989). This means that teachers feel that they learn more about teaching and improving their practice by teaching in the classroom than any type of professional development. However, without any reflection or outside guidance, direct teaching experience could lead to teachers acquiring unproductive teaching habits. One way that teacher professional developers are trying to increase transfer to instructional practice is by incorporating classroom materials into training sessions. Lesson plans, student work, and videotaped lessons are all examples of artifacts that can be used in professional development situations to create a more authentic atmosphere.

Another way to create situated learning opportunities for teachers is to generate situations in which teachers must learn new skills in order to facilitate student learning. GrassRoots was a program that allowed K-12 students to create Web pages based on any topic and publish them as a class (Slepkov, 2008). In the program, K-12 teachers worked with facilitators on an as needed basis throughout the completion of the class web project. The teachers also submitted reflective reports that described the pedagogical changes

they had made throughout the process. Teachers involved in the program reported improving their technological skills and reported plans to continue with the program in the future (Slepkov, 2008).

In order for professional development to lead to a long term changes in teachers' attitudes and behaviors, it must be: supportive, job-embedded, instructionally-focused, collaborative, and ongoing (Hunzicker, 2010). These aspects are especially important when introducing technology because teachers are often faced with both learning the technology and changing their instructional beliefs and practices.

Issues Related to Technology Professional Development

Resources, institutional support, subject culture, attitudes/beliefs, knowledge/skills, and assessment have all been identified as barriers to technology integration (Hew & Brush, 2006). Hew and Brush (2006) identified 123 barriers from empirical studies about technology integration and found that teachers' lack of technological knowledge and skills was second only to *lack of resources* as a barrier. Recently, a national survey conducted by the U.S. Department of Education found that ninety-seven percent of teachers had at least one computer in their classroom, and fifty-four percent were able to bring computers into their classrooms for technology focused lessons (Gray, Thomas, Lewis, & Tice, 2009). Despite this access to computers, only forty percent of the teachers reported that their students used technology "often" during instructional time and the types of technology and level of its integration varied widely across the participants (Gray et al., 2009). In the same survey, fifty-three percent of the teachers attended only 1 to 8 hours of technology professional development in the past

year (Gray et al., 2009). Due to the busy schedules of in-service teachers, technology professional development must be targeted to achieve the most growth within teacher learners in a limited timeframe.

Another difference between pre-service and in-service teachers is *level of teaching experience*. In-service teachers' experiences may impact their use of new technologies. Kagan states that "as a teacher's experience in classrooms grows, his or her professional knowledge grows richer and more coherent, forming a highly personalized pedagogy-a belief system that constrains the teacher's perception, judgment, and behavior" (1992, p. 74). In case studies of teachers with six or more years of teaching experience, Hervey (2009) found that teachers' attitudes about technology as an instructional tool greatly influenced the ways they incorporated technology in their classes. These teachers' technology use was consistent with beliefs they stated during interviews (Hervey, 2009). This study also revealed that experienced teachers, who have a more developed and stable pedagogical content knowledge, may have more difficultly integrating technology that conflicts with their beliefs or instructional preferences. Additionally, Zhao et al. (2002) found that teachers who proposed technology grant projects that were aligned with their pedagogical beliefs and practices were more likely to be successful in those projects than those who did not align their projects with their beliefs. One teacher in particular was inspired by a workshop to take on a new pedagogical approach, but was still unable to fully implement her technology project due to a lack of fully understanding the new theory and its underlying assumptions, and lack of commitment to the theory in the face of challenges (Zhao et al., 2002). In the same

way, if a teacher already holds constructivist or socio-constructivist views about teaching, he or she may be more likely to integrate technology in those ways.

Ertmer (2005) proposed that since initial experiences both with teaching and with technology shape teachers' future actions, their "personal theories and beliefs are rarely sufficiently revised and, thus over time, become deeply personal, highly engrained, and resistant to change" (p. 30). All new information and technology that teachers encounter is filtered by their prior beliefs, and these beliefs play a considerable role in whether or how technology is adopted into a teacher's practices. Kagan (1992) argues that most of teacher knowledge is better classified as beliefs and she summarizes multiple qualitative studies where teachers' beliefs are reflected in their instructional practices. Niess (2006) called for professional development that "recognize[s] and emanate[s] from the teacher's experiences and provide[s] them with extended experiences in teaching mathematics with technology" (p. 198).

Teachers' belief systems are complex and often contradictory. Their stated beliefs may contradict their enacted teaching practices (Ertmer, 2005). Although beliefs are difficult to uncover, *pedagogical preferences* can be determined by observing teachers or surveying them about their teaching practices. In this study, pedagogical preferences will refer to the types of instructional activities that a teacher employs regularly in the classroom. Yinger (1979) found that teachers tended to use a limited number of activities and routines repeatedly when planning for lessons. The routines were "used to establish and regulate instructional activities and simplify planning" and "to increase the predictability and to reduce the complexity of the teaching environment"

(Yinger, 1979, p. 165). It is these regular routines and activities that make up an individual teacher's pedagogy. Understanding a teacher's preferred pedagogy may help development programs adapt technology training to teachers' needs. Grasha & Yangarber-Hicks (2000) surveyed college faculty about their teaching style in two different university courses they were currently teaching or had previously taught. They were to choose one traditional course that used little to no technology and a course that used technology regularly. In the technology courses, faculty reported using an average of four different types of technologies (Grasha & Yangarber-Hicks, 2000). There were no significant differences between teachers' responses in the technology course and the traditional course on any of the five teaching style subscales, indicating that technology use did not change the way in which they taught (Grasha & Yangarber-Hicks, 2000). Cuban, Kirkpatrick, and Peck (2001) found similar results. The addition of technology itself did not change the teaching practices of teachers (Cuban et al., 2001).

For many teachers, teaching with technology can be a new and challenging experience. Even experienced teachers may revert to novice teaching habits when faced with new technology (Pierson, 2001). For this reason, it is important that teachers have continued support when they are attempting to integrate a new technology into their teaching.

In addition to a teacher's pedagogical preferences, his or her *beliefs about technology and various tools* can influence adoption or rejection of specific technological tools. Hughes (2005) noted that while the teachers were exposed to several types of technology, they continued to learn and use only technologies that they perceived as

useful to themselves and their students. In a case study of three teachers, Pierson (2001) found that teachers' use of technology in their classroom was closely tied to their personal beliefs about the uses and affordances of technology in general. For example, one teacher's beliefs about the entertainment value of technology led him to use computer time as a reward for good behavior rather than as a means to teach content. On the other hand, another teacher saw technology as a tool that could be used effectively to teach content matter. She thought critically about objectives for her students and integrated technology when she felt that it would improve her students' learning (Pierson, 2001). Although some studies have suggested that over time technology leads to adoption of more constructivist strategies (Sandholtz, Ringstaff, & Dwyer, 1997), Windschitl and Sahl (2002) found that although some teachers did adopt more constructivist practices during a two year laptop initiative, those changes seemed to be driven by a shift in their beliefs independent of the computers. Technology alone cannot change teacher beliefs or practices; sustained professional development is needed to support teachers through this difficult process.

Technology Professional Development

As previously mentioned, the definitions of technology have shifted over the last thirty years. During this time a number of types of trainings have been used to meet these goals. Early proponents of technology believed that simply equipping schools with technology would spur teachers to integrate technology into their teaching in constructivist ways (Cuban, 1986). However, these technology-based reforms often concentrated on simply giving teachers access to computers or other technologies,

without any training. The thought was that teachers did not use technology because of a lack of availability, and with ample technology access, teachers will begin to integrate the tools into their teaching practices on their own. Not surprisingly, these studies found that simply supplying teachers with new technologies did not lead to an increased technology use in the classroom (Cuban, 1986; Macmillan, Liu, & Timmons, 1997; Sandholtz, Ringstaff, & Dwyer, 1997; Windschitl & Sahl, 2002; Zhao, Pugh, Sheldon, & Byers, 2002).

The next step in the technology integration movement was to begin standardized professional development workshops. These trainings tend to be standardized workshops that focus on the affordances and constraints of the technology rather than its ability to facilitate learning (Harris, 2005). Teachers learn how to operate the technology, but not how to use it in their teaching. Though this approach also had limited results in its ability to affect change in the technology use in the classroom (Valanides & Angeli, 2006), it is still a popular method for technology professional develop and will be discuss further in the next section.

A third approach to technology professional development is through the use of university courses. Technology courses are available to in-service teachers as stand-alone classes or as part of a graduate level degree, but these classes require large monetary and time commitment on the part of the practicing teacher. University courses may also feel removed from the actual school environment where those teachers work.

Traditionally, most technology professional development focused on developing the technology skills first (e.g., Knapp, 1996; McCannon & Crews, 2000), rather than on

how the technology helps accomplish subject matter objectives or how it enhances pedagogical techniques. Newer approaches focus on how to effectively integrate various technologies into content specific situations. In cases of in-service teachers, Hughes (2005) found that content based learning experiences generated more content-based technology integration. Activity type training and design-based trainings are two approaches that attempt to imbed technology professional development in the teachers' content area (Angeli & Valanides, 2009; Harris & Hofer, 2011). However, both of these methods are still lacking key components of effective professional development. Technology-focused lesson study is a new approach to technology professional development that is being considered in the K-12 setting (Calvin, 2008; Hughes, Kerr, & Ooms, 2005; Pierce & Stacy, 2009; Whisenhunt, 2009). Table 1 summarizes the key components in each of these approaches to professional development. A more in-depth description of these types of professional development follows.

Table 1

Components of technology integration professional development

	Professional Development Approaches			
Components of Technology PD	Workshops	Activity Type Training	Design-Based Training	Technology-Infused Lesson Study
Technology Skills	X	X	X	X
Content-Specific	Occasionally	X	X	X
Observation of Tech. Use	Occasionally	X	-----	X
Active Planning	Occasionally	Occasionally	X	X
School/Context Based	Occasionally	-----	Somewhat	X
Teacher Collaboration	-----	-----	X	X
Sustained Support	-----	-----	Occasionally	X
Reflection	-----	-----	-----	X

Each of the types of professional development mentioned stems from learning theory. The following sections describe the professional development, discuss the theory behind the training, and highlight potential drawbacks of each professional development.

Information processing approach: Workshops. Traditional technology training focuses on the constraints and affordances of the technology itself and tends to be presented in an information processing format. In 2000, a survey of 127 Georgia elementary school teachers looked at the availability and attendance of various types of technology professional development (McCannon & Crews, 2000). Word Processing trainings and trainings about operating systems were available to more than 65% of the teachers, while trainings concerning technology integration into curriculum were available to only 52% of teachers (McCannon & Crews, 2000). The word processing training was ranked as the most beneficial type of technology training, followed by the curriculum integration professional development. Despite the availability and attendance of technology training, only 19% of the teachers reported using technology to enhance their lectures or presentations in class, indicating that while the training was beneficial for making teachers' administrative tasks more efficient, it was not having a large effect on their actual teaching practices (McCannon & Crews, 2000).

Theoretical and research underpinnings of traditional workshops. In the early 1970s, learning theorists began a shift away from behaviorist theories and began to focus more on the brain as a processing center. The invention of the computer facilitated this movement by acting as a model for the brain, frequently referred to as an "information processing" model of learning. The "modal model" of the brain proposes that three parts,

the sensory register, short-term memory, and long-term memory, work together for learning to occur (Atkinson & Shiffrin, 1968). In this model, information that is sensed by the brain and attended to moves into the short term memory. The short term memory has a limited capacity so information must move into the long-term memory if it is to be remembered at a later time. In order for new knowledge to become long term memories, it must be organized and connected to one's current knowledge. Learning occurs when the new information is integrated into the person's long-term memory. Although learning theories have begun to look at more complex models of the brain and how learning occurs, the ideas of attention and memory capacity are still relevant in current learning psychology.

Instruction under the information processing theory centers on the expert teacher presenting information to students. The Select-Organize-Integrate model (Mayer, 1999) outlines a three step process for teachers to present information in a way that is learning-friendly. First, the teacher is responsible for selecting the key concepts that students need to learn. Mayer (1999) offers several ways that teachers can cue students that this information is important. Secondly, Mayer (1999) stresses that the teacher should present the information in an organized way so that students will be able to understand the connections between new and old material. Finally, teachers should provide examples to tap into student's long-term memory so that new material will become integrated into the student's existing knowledge. This approach is teacher-centered because it places most of the responsibility for learning on the instructor. The focus is on the teacher's actions and how well they convey the information, rather than on what the students are doing.

Potential drawbacks. In-service workshops tend to focus mainly on explaining the functionality of the technology but offer little to no support for teachers in integrating the technology into content area teaching, an approach consistent with an information processing model of learning. Additionally, workshops can tend to be short half-day or day long events that are often held in district offices away from the regular classroom. Workshops often do not allow time for the teachers to see the technology being used as a teaching tool or to think about how they can use the technology in their classroom to enhance learning. Without these components, teachers may become more familiar with technology, but still be unable to facilitate student use of that technology in the classroom.

A final problem with workshops is their lack of focus on individual teacher needs and prior knowledge. School and district trainings are often presented to a diverse group of teachers in terms of skill level, grade-level, and content area taught. This variation can make it difficult for staff developers to meet the needs of all the teachers in attendance.

Social cognitive approach: Activity type training. Technology Integrated Activity Type professional development, another method based on social cognitive theory, uses modeling of specific pedagogical activities to teach appropriate context-specific uses of instructional technology (Harris, Mishra, & Koehler, 2009). Building on Putnam and Borko's (2000) ideas about teachers' situational and event-structured thinking, activity types professional development begins by identifying content specific learning activities. Research has shown that teachers plan by creating sequences of these "routinized activities" (Tubin & Edri, 2004; Yinger, 1979). In an in-depth study of one

teacher's planning, Yinger (1979) found that the teacher's "planning could be characterized as decision making about the selection, organization, and sequencing of routines" (p. 165). In case studies of elementary teachers lesson planning with technology, Preito, Villagrá-Sobrino, Jorrín-Abellán, Martínez-Monés, and Dimitriadis (2011) also found that the teachers were using a set of activities or routines to create their lessons. Instructional routines or activity types are learning activities that have clear processes, behavioral norms, and learning outcomes (Harris & Hofer, 2009; Yinger, 1979). In this technology integration approach, the activity types for a particular content area are identified, and then technology that supports those activities is chosen and incorporated. For example, a common mathematics activity is to have students interpret a representation (i.e. table, graph, chart). This is an example of an "activity type" geared at helping student understand the mathematical relationships depicted in the graph. Technologies such as databases and data visualization software can help teachers and students understand the concept (Grandgenett, Harris & Hofer, 2011). "Activity types" are organized by the learning objective and can be used to show any type of teaching (Harris, 2008; Harris et al., 2010). In an activity type professional development, the integration of technology into a wide variety of activity types is modeled so that teachers see how their content and existing teaching strategies can be improved with technology.

Theoretical and research underpinnings. This second type of training, activity types training (Harris, Mishra, & Koehler, 2009), stems from social cognitive theory. The paradigm focuses more on the interaction between the learner, the environment, and the behavior. According to this theory, learning occurs through reciprocal interaction between personal factors, the behavior being learned, and the environment. Modeling is a key component of social cognitive theory.

Modeling of behaviors can serve three functions for learning within the social cognitive framework: response facilitation, inhibition/disinhibition, and observational learning (Bandura, 1986). In response facilitation and inhibition/disinhibition no new behaviors are being learned, but the frequency of behaviors already known by the learner increases after observation. Response facilitation occurs when one's behavior prompts others to behave in a similar way. For example, when a teacher, who has previously used color coded behavior charts, starts at a new school and sees all color coded behavior charts in all of the other teachers' classrooms, she is likely to use a color coded behavior chart in her class as well. In inhibition or disinhibition known actions are either strengthened or weakened by watching the reactions to other people performing those behaviors. For example, during a staff meeting if the principal recognizes a teacher for taking her students to the library, other teachers may begin to take their students to the library more frequently. These teachers may have previously been taking their classes to the library, but the reinforcement of the model teacher causes them to perform the behavior more often. Conversely, when a teacher is corrected for spending too much

time with their students at recess, other teachers might start to have shorter recess periods for their students.

Observational learning is the only function of modeling where new behaviors are learned. In order for learning to occur, four processes must take place: attention, retention, production, and motivation (Bandura, 1986). The first step is that the student's attention must be drawn to the key components or actions that comprise the new behavior. Second, the information must be retained. Retention can occur through practicing the behavior and by connecting the new knowledge to prior knowledge and experiences and creating mental models of the target behavior that can be recalled later when the behavior is displayed. The third process, production occurs when the learner moves from understanding the behavior into actually performing it themselves. During production, complex behaviors are perfected through guided practice with feedback.

As mentioned above, *personal factors* and *task characteristics* are central to social cognitive theory because they affect a person's motivation to attend to and retain behaviors. These factors are the components of motivation and can influence how much time and effort teachers put into the production of the learned behaviors.

Personal factors include one's perception of the ability to successfully complete the task, also known as self-efficacy. Self-efficacy has been shown to affect the amount of persistence a teacher demonstrates after a difficulty or failure (Gibson & Dembo, 1984). Efficacy is largely dependent on the task. For example, one may have very high efficacy in mathematics, but low efficacy in sports. High technology self-efficacy has been associated with adoption of new technologies in the classroom (Lee & Tsai, 2007).

In a study of Taiwanese K-12 teachers, Lee & Tsai (2007) found that teachers' web-self efficacy was positively correlated with their attitudes toward and use of web technology in the classroom, but negatively correlated with years of teaching experience, indicating that more experienced teachers had lower technology self-efficacy than new teachers. Self-efficacy can be increased through personal success, persuasion of others, and vicarious success of others (Bandura, 1986).

Task difficulty and the perceived value of the task can also impact a person's self-efficacy and motivation to learn new behaviors. If the learners feel that a behavior is valuable, they are more likely to pursue learning and practicing that behavior despite setbacks (Atkinson, 1957). In the same way, teachers' value of technology as a teaching and learning tool can impact their commitment to technology professional development and technology integration in the classroom. Hughes (2005) noted that while the teachers were exposed to several types of technology, they only continued to learn and use technologies that they perceived as useful to themselves and their students.

Learners are more likely to feel efficacious when they perceive that the model engaging in the behavior has comparable skill level to their own (Schunk & Zimmerman, 2007). In the same respect, teachers are more likely to trust information and suggestions from fellow teachers than other professionals (Fullan, 2007). Corcoran et al. (2001) found that while district staff felt strongly about professional development being research based, teachers placed more importance on advice from other teachers and were ill-equipped to interpret scientific research or judge its significance.

The third component involved in the social cognitive model of learning is *the environment*, which includes both the physical structure and the social context in which the learning occurs. In schools, the physical structure includes the layout of the classroom as well as the inanimate objects or tools available to the students and teacher. The social context includes direct contact with others, indirect observations of others, and the behavioral norms and expectations within that context. People learn not only from the consequences of their behavior, but also from the consequences experienced by others. Rather than serving as reinforcement or punishment, consequences are thought to give students information and motivation about how they should behave in the future. Observing others perform a behavior and the resulting consequences can provide students with the same information and motivation as personal experience. This environment-specific component is one key piece missing in current forms of activity types training.

Outcomes. While modeling of teaching with technology and activity type training have shown some promise with pre-service teachers (Brush et al., 2003; Lee & Hollebrands, 2008; Niess, 2005), little research has been done on the use of this professional development type with in-service teachers. In 2011, Harris and Hofer reported the results of an activity type professional development with seven high school social studies teachers. After the training, the teachers indicated that they chose activities that "emphasized using technology to intellectually, rather than affectively, engage their students (Harris & Hofer, 2011, p. 222) in direct contrast to their planning goals prior to the professional development. While content-matter remained the primary focus of

teachers' planning decisions, teachers were more thoughtful in their planning decisions and in decisions about incorporating technology after the training.

Potential drawbacks. Activity-type training is missing several components of technology professional development: reflection, teacher collaboration, school/ context basis, and sustained support. The first major concern of activity-type training is that it does not endorse any pedagogical approach (Harris & Hofer, 2011) and therefore does not encourage teachers to reflect on or examine their current teaching practices. In this approach, technology integration is more about the "fit" of the technology with the content and pedagogy than with the idea that students should be engaging with the technology in constructivist ways.

Activity-type training is also missing a component of teacher collaboration. Teachers interact only with models, but are not required to plan with other teachers or to get any feedback on their lesson planning. The third problem with this training is that it is often not school-based. The training is situated within the subject area content, but often takes place in a university setting. University classrooms may use pre-service and in-service teachers as the audience for the modeled lessons rather than children. Even when these modeling sessions occur in a school setting, it is often in the context of pre-service teaching and not in the school where these teachers will eventually work. Activity type training makes an attempt to situate the technology into the teaching context, but does not offer ongoing support in the actual school environment of the teachers.

Socio-constructivist approach: Design-based learning. Design-based learning includes all types of professional development that focus on developing course materials as a way to increase technology integration. These trainings typically involve teachers working in groups to create technology integrated student assignments or lessons with very little direct instruction about technology or pedagogy.

Learning Technology by Design (Koehler & Mishra, 2005a, 2005b; Koehler, Mishra, & Yahya, 2007) is a technique that has begun to be used in teacher technology courses to facilitate technology integration in the classroom. Koehler and Mishra characterized Learning by Design as " a constructivist approach that sees knowing as being situated in action and co-determined by individual-environment interactions" (Koehler & Mishra, 2005a, p. 134). However, the trainings are all conducted in groups where less technology-skilled teachers work with more technology-skilled teachers or professionals to design course materials. This collaboration makes the training socio-constructivist, rather than constructivist, in nature.

Collaborative Lesson Design, a similar process to Learning by Design, was used with pre-service teachers in Singapore (So & Kim, 2009). In this study, pairs of pre-service teachers worked together to create a problem based learning (PBL) lesson plan that integrated technology. At the end of four weeks, pre-service teacher pairs submitted their lesson plans and completed a survey about their perceptions of the project, PBL, and technology use in the classroom. While the teachers were able to correctly identify and explain the majors components of PBL on the survey, they had difficulty integrating technology effectively, creating ill-structured questions, and

incorporating scaffolding into their lesson plans (So & Kim, 2009). Since the pre-service teachers demonstrated understanding of PBL structure, they themselves may have needed more scaffolding in how to generate appropriate questions and support PBL with technology.

Theoretical and research underpinnings. Design-based professional development stems from socio-constructivism. Contrary to social cognitive theory where the learning is a result mainly of observing others, learning in socio-constructivism occurs through the negotiation of meaning with others. The learner is responsible for building connections between the new material and their prior knowledge rather than the burden being on the teacher. Learning is situated, social, and distributed among the group of learners (Putnam & Borko, 2000). In socio-constructivism, the teacher serves as a facilitator or mentor of learning rather than the director of the students' learning. The majority of learning occurs through interactions with more knowledgeable peers.

According to Vygotsky (1978), learning occurs in the *zone of proximal development* (ZDP) with the aid of scaffolding. The ZPD is the distance between a learner's independent ability and their ability with the help of a more skilled person or instructional tool (Wertsch, 1991). Scaffolding is the process by which an instructor or peer mentor supports the learner to increase their understanding. Asking questions, offering hints, and elaborating are some strategies that can be used to scaffold learning. Not only does the less knowledgeable peer learn from this pairing, but both learners work to create a shared understanding of the concepts (Roschelle, 1992; Tudge, 1992). Collaborative learning experiences have also been used in some teacher professional

development. Desimone et al. (2002) found a significant difference in teacher trainings designed to improve math and science teaching that used collective participation.

Communities of Practice are another key component of the socio-constructivist theory. In the communities of practice model, novices start at the periphery of a community and move into a more central role as they learn through mentoring (Lave & Wenger, 1991). In this situation, both the learners and the expert/mentors in the community learn as a result of the interactions. In a study of grant funded teachers implementing technology projects, Zhao et al. (2002) found that teachers who were more "socially aware" had more successful completion of their projects. The "socially aware" teachers looked to others within their school or district for support when they encountered problems. They were also aware of the school context/culture and expectations and constraints of that setting (Zhao et al., 2002).

A final component of socio-constructive theory is that all learning is situated in context. According to Vygotskian principles, "mental functioning is inherently situated in social interactional, cultural, institutional, and historical contexts" (Bonk & Cunningham, 1998 p. 35). Because of this principle, "learning is most effective when it approximates real-world situations or problem scenarios" (Wertsch, 1991). Putnam and Borko (2000) propose a number of methods for situated teacher training including: in-school or classroom based professional development, pre-service apprenticeships with experienced teachers, and teacher discourse communities.

Outcomes. Design-based professional development can have different outcomes depending on the type of materials that the teachers are designing, but most of the studies show that teachers become more aware of their students as an audience, and therefore are more attentive to students needs (Girod, Bell, & Mishra, 2007; Koehler & Mishra, 2005). In 2007, teachers in two graduate levels classes designed instructional videos for their students (Girod, Bell, & Mishra). Throughout a semester long course, these teachers worked in groups to develop technology tools they could use in their classes. Qualitative analysis revealed that teachers had become more aware of the planning process and more attentive to students needs; however most of the teachers did not plan to continue to make videos for their students after the class ended (Girod, Bell, & Mishra, 2007). In another master's course, teachers worked in groups of four to redesign websites and web tools for educational purposes (Koehler & Mishra, 2005). Again the teachers became more aware of their students' needs. They also gained technology skills relating to their specific projects. No follow-up was done to see how and if the teachers planned to use technology after the class (Koehler & Mishra, 2005).

Angeli & Valanides (2009) propose a process called technology mapping to guide pre-service teachers toward creating technology integrated lessons. During a semester course, pre-service teachers were taught and practiced an instructional design model that guided them in developing a technology integrated learning activity. The first step in the model involved brainstorming several difficult topics within a content area. Second, the teachers identified specific learning objectives that target students' misconceptions of those topic areas. Technology integration began during the third step of the process,

where pre-service teachers mapped technological affordances onto the content areas. Mapping is the "process of establishing connections among affordances of a tool, content, and pedagogy" (Angeli & Valanides, 2009, p. 161). At this point in the process, both peer and self assessment of the topic chosen and the effectiveness of the technology occurred. Based on this feedback, students revised their lessons before they were graded by the professor. While this is a guided approach to creating a lesson, this type of training follows the socio-constructivist approach of starting with an ill-structured problem and collaborating with others to arrive at a solution. Over three separate semesters, pre-service teachers showed a significant improvement in technology integration from the first to the second lesson plans they created (Angeli & Valanides, 2009). In qualitative feedback, students identified four important steps to the process: 1) gathering initial information, 2) engaging in real-world authentic tasks, 3) sharing and reflecting with peers, and 4) discussing their solutions with experts (Angeli & Valanides, 2009).

Potential drawbacks. Design- based approaches do not usually include opportunities for teachers to see technology modeled in a teaching setting. Instead, teachers are thrown into designing materials and must figure out the technology as they try to design their final product. This can lead to haphazard technology learning. This is especially problematic because most of the design-based professional development takes place in university courses and teacher institutes. Both of these settings are removed from the teachers' actual classrooms causing a disconnect between the new technology learning and future teaching. Because of this disconnect, teachers may design technology

resources and lesson plans that do not fit well into their actual classrooms because of available technology resources or issues of school culture. The final problem with design-based trainings is that they do not follow teachers through the implementation or use of their newly designed materials. Without this continued support teachers may encounter unforeseen circumstances that cause them not to implement technology in their teaching after the training has ended. Without implementation, there is little to no opportunity for reflection on the success of the new technology materials.

Lesson Study Professional Development

Lesson study professional development combines the modeling of activity type training with the design aspects of design-based training. Additionally, lesson plan study is school-based and therefore offers a more sustained network for support both during and after the process. Reflection is another component of lesson study that is not found in the other types of technology professional development.

Originating in Japan, lesson study (*kenkyujugyou)* professional development is a collaborative process in which teachers work to create and refine a "research lesson" (Lewis, 2002). A research lesson is the lesson plan designed, studied, and revised by the lesson study group. In 1999, the technique was introduced to educators in the United States in *The Teaching Gap* (Stigler & Hiebert, 1999). This book not only provided a detailed description of the process, but also urged U.S. schools and teachers to test the lesson study process. Stigler and Hiebert hypothesized "that if our educational system can find a way to use lesson study for building professional knowledge of teaching, teaching and learning will improve" (p.131).

In lesson study professional development, teachers work together to create a "research lesson" that they then develop and refine through a cycle of observation and reflection. There are four essential components to a lesson study cycle: a shared long-term goal, important lesson content, careful study of students, and live observations of lessons (Lewis, 2002).

1. The shared long-term goal is typically a school-wide goal that can span one or more years. In Japan, the goals tend to be very broad goals, visions, or mission statements rather than specific, measurable objectives (Lewis, 2002).
2. The content area is usually chosen by the teachers based on weaknesses in student learning, teaching difficulties, changes in the curriculum, or content areas that are associated with large amounts of instructional time (Lewis, 2002). Both in Japan and the U.S., lesson studies are used most often in mathematics instruction (Lewis, 2002), but are suitable for use in all content areas.
3. The third component, careful study of students, is based on the idea that during the planning, observing, and revising of the lesson, the focus should be on the student behaviors and learning rather than on specific teaching behaviors. In the lesson study process, the teachers are refining a specific lesson in response to student cues rather than evaluating "good teaching".

4. In order for this to be accomplished, the teachers must have the opportunity to observe students as they experience the lesson. In the live observations, teachers can gather data about "students' engagement, persistence, emotional reactions, quality of discussion with-in small groups, *tsubuyaki* (under-breath exclamations), inclusion of groupmates, degree of interest, and so forth" (Lewis, 2002, p. 11).

In the lesson study process, these four components are realized through a collaborative process with several steps. The group first establishes or reviews a shared long-term goal and chooses an appropriate content area. In the second phase, the teachers work together to create a detailed lesson plan (Fernandez, 2002). This stage allows teachers to share ideas and best practices with each other. It also allows for the critical discussion and reflection on different instructional methods. The "research lesson" includes not only what the teacher will do, but also anticipated student responses. After the lesson is created, one teacher volunteers to enact the research lesson with real students. This is where live observations occur. All other group members observe the sample lesson with a special interest in the students' answers, engagement, and reactions to the lesson. Again, the focus here is not on the teacher, but on the lesson itself and how students respond to the different components within it (Lewis, 2002). In the debriefing after the research lesson, the group may decide to keep the lesson as is, make slight modifications to the lesson, or revise the lesson completely. If the lesson is significantly altered, a second lesson enactment should be done. When the group is satisfied with their lesson plan, they work together to create a written reflective document. The report

describes the process that the group followed and what they learned as a result of the lesson study (Fernandez, 2002). The report should also contain a final version of the research lesson.

Reflection is also an essential component of the lesson study where the group meets to discuss ways to improve the lesson or unit and teaching practices. The process is similar to inquiry or action research (e.g., Hughes, Kerr, & Ooms, 2005), but is always focused on a particular lesson and happens within a group rather than individually, as is sometimes the case in inquiry research. Lesson studies also contain aspects of teacher observations, but are pushed a step further because the teachers have developed the lesson together, rather than the novice teachers simply observing a master teacher. Lewis (2009) presents a case study that shows evidence of increases in pedagogical knowledge as well as changes in interpersonal relationships and teachers' attitudes toward learning and improving after participation in a lesson study.

With all of its components, lesson study meets all five criteria for effective professional development: supportive, job-embedded, instructionally-focused, collaborative, and ongoing (Hunzicker, 2010). The members of the lesson study group provide support for each other as they design and implement the lesson plan. This support is especially important when teachers are working to change their beliefs and practices. Lesson study is school- based and relates directly to the critical needs of teachers and students. The focus on student learning during the "research lesson" helps ensure that the process of lesson study is instructionally-focused. The cyclical process of lesson study provides ongoing opportunities for continued improvement in teaching. And

finally, the group works in collaboration to create a lesson and reflective document that can be used in future collaboration with teachers outside of the lesson study group. Integrating technology into teaching often requires a change in their beliefs and practices. Because of the robust nature of lesson study professional development, it may be very effective in helping teachers incorporate technology.

Technology-Infused Lesson Study

Technology-infused lesson study is the same as regular lesson study except that the research lesson is required to include student use of technology. The type and amount of technology use is decided by the lesson study group. As previously mentioned, adding a technology aspect to the lesson study process accomplishes all of the goals of effective professional development. The technology-infused lesson study also aligns with Guskey's process of teacher change (2002). In the change process, teacher beliefs change only "*after* people have had at least some behavioral experience in attempting new practices" (Fullan, 2007 p.37). Figure 2 shows the alignment of the steps in Guskey's (2002) teacher change with the steps of technology-infused lesson study.

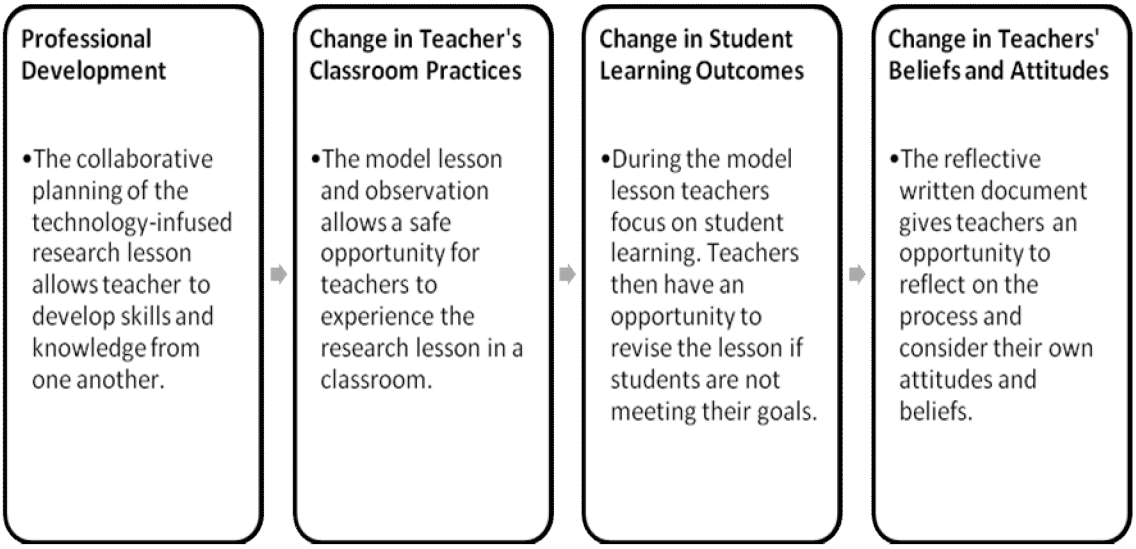


Figure 2: Model for teacher change in technology-infused lesson study.

To date, little research has been done on the impact of the complete lesson study cycle on technology integration. Mouza and Wong (2009) used a case development strategy in a graduate level course. This process is similar to lesson plan study in that teachers take real class lessons, reflect upon them, refine them, and then create a reflective case study to share with other teachers. However there are two main differences, the case study approach is done individually and retrospectively. Teachers do not get the opportunity to learn from others or the benefits of strategically planning their lesson. In 2005, Hughes, Kerr, and Ooms studied teachers in inquiry groups, but these teachers supported each other through individual lessons and projects rather than working together to design one research lesson. Observation was another component of lesson study missing in the inquiry groups. Even without that shared planning, teachers in the group felt that they learned from each other and considered new technologies

suggested by their peers (Hughes et al., 2005). One of the teachers did dismiss their peers' suggestions about the appropriateness of technology. Researchers speculated that more emphasis on data-based decision might counteract such a problem (Hughes et al., 2005). The observation of the "research lesson" in lesson study is one way that teachers could gather data to support their suggestions or critiques.

Tee and Lee (2011) described a problem-based learning professional development in Australia that resulted in an increase in TPACK for 24 in-service teachers enrolled in a 14-week course. During the first section of the course, teacher developed problems related to teaching with technology. The teacher then developed and piloted their solution. The final part of the course was dedicated to writing a wiki chapter about their experience and sharing it with the class. In self-report surveys and interviews, teachers expressed an increase in TPACK following the course. Teachers were also able to move from a mindset of "blaming the students" for the problems to redefining the issue as the teacher's problem (Tee & Lee, 2011, p. 98). This approach is closer to the lesson study process, but is still removed from the school context where the teachers work. Calvin (2008) discussed the use of technology-infused lesson study with pre-service teachers. Unfortunately, since the pre-service teachers were not currently teaching, they were only able to have microteaching observations of the research lessons, reducing the impact of real classroom observations.

In mathematics education, technology-infused lesson study has been used to help teachers understand the possibilities of mathematics software. One study described the process of researchers who created a math lesson using TI-Nspire calculators to solve

quadratic equations and then implemented it in nine classrooms (Pierce & Stacy, 2009). Here, the researchers, rather than the teachers were the ones participating in the lesson study. The teachers involved did not develop the lesson and served only as the model teachers for the class observations. At the end of the process, the researchers felt that technology could be helpful in teaching math if it was focused on content goals and technology distractions were reduced (Pierce & Stacy, 2009). Data were not collected from the teachers involved in the process.

In addition to the strengths of lesson study as a professional development activity, Groth, Spickler, Bergner, and Bardzell (2009) proposed using the data from a technology-infused lesson study as a way to assess teachers' TPACK qualitatively. Groth et al. (2009) highlighted the rich set of data sources that is created during a lesson study cycle. This includes lesson plans, observation notes, and reflective documents. This research study focuses on an elementary school site that is implementing technology-infused lesson study. The data collected from the teacher groups participating in technology-infused a lesson study cycle is used to understand the teachers' experiences as well as any changes in their TPACK or teaching practices.

Research Questions

Borko (2004) suggested a three phase model to evaluating professional development. The first phase deals with creating "existence proofs of effective professional development" (Borko, 2004, p. 5). In this phase, researchers are concerned with establishing "that high-quality professional development programs can help teachers deepen their knowledge and transform their teaching" (Borko, 2004, p. 5). This type of

research is usually done using a single site with multiple forms of data in order to really understand the components of the training, the participants, and the changes that occur in the participant's beliefs and practices. Phase two begins to look at whether a professional development can be scaled up and transferred to other sites. In the third phase, well-established professional development is compared to other types of professional development using a more experimental approach. In a survey of technology professional development literature, Lawless and Pellegrino (2007) pointed out that thick description of the professional development process is often missing from research articles. Without this important information, it is impossible to compare the results across studies. The authors called for researchers of technology professional development to take a similar three-phrase approach to evaluating the professional development. Phase one should explain the type and duration of professional development, the content of the professional development, and the technology support needed and available during the professional development (Lawless & Pellegrino, 2007). The second phase focuses on the teacher's knowledge, attitudes and instructional behaviors to judge the impact of the professional development on the teacher. Finally, Lawless and Pellegrino (2007) urged researchers to look at student outcomes. In this final phase, the success of the professional development is evaluated based on the whether the teacher changes led to measure changes in student behaviors or learning. While this is an admirable goal, it is difficult to isolate the effects of professional development training on student outcomes.

Because technology-infused lesson study is a relatively new professional development, my research took an approach that combined Borko's (2004) phase one and Lawless and Pellegrino's (2007) phase two. This meant focusing in-depth on one school site using a qualitative approach to capture the experiences of the teachers in technology-infused lesson study.

In this study, I investigated the following questions about a technology-infused lesson study professional development in a public elementary school conducted during one semester:

1. How did teachers in a technology-infused lesson study group develop (a) their attitudes toward technology and (b) their technological pedagogical content knowledge (TPACK)?
2. How did teachers in a technology-infused lesson study group change their lesson planning and teaching behaviors?
3. Were there features of the group (such as membership, grade level, subject matter, group interactions, etc.) that played a role in the teachers' development?

Chapter 3: Methods

Site of Study

Openwood[1] Elementary School is one of 170 elementary schools located in a large urban school district in the southwestern United States. The district serves over 200,000 students and employs more than 12,500 teachers. Openwood serves about 600 of these children ranging from pre-kindergarten to sixth grade. In the past, the school has consistently met their annual yearly progress and received high rating in the district. However, in the 2010-2011 school year (the year prior to the study), the school did not meet the district's annual yearly progress standards and fell to only an acceptable rating. The school receives Title I funds from the federal government.

Thirty-three teachers, with an average of 15 years of experience, worked at Openwood in 2010-2011. In the year prior to this study, half of the teachers had 11 or more years of experience and 30 % of the teachers held a master's or doctoral degree. Teachers at the school were divided into two programs, the traditional school system and a Montessori charter program. Under the traditional system, the teachers follow the district curriculum and sequencing guide. Teachers of kindergarten, first, and half of the second grade have self-contained classes. The rest of the second graders and all higher grade levels are in departmentalized classes. This means that they rotate through more than one teacher, and each teacher focuses on only one or two subjects. The self-

[1] All school and teacher names are pseudonyms

contained classes all have students from two consecutive grade levels. Departmentalized teachers also have students from two grade levels, but they meet with the students separately. For example, a teacher may teach third grade math in the morning and second grade math in the afternoon. On the other hand, all of the Montessori classes are self-contained multi-level classes that serve students from three consecutive grades (PK-3-K, 1-3, and 4-6).

Student Population

The student demographics of the school from 2010-2011, the most recent available, are shown in Table 2. The student population is about half Hispanic and low socioeconomic status, with 58% of the students qualifying for free or reduced lunch, 54% classified as at-risk students by the district, and 30% labeled as Limited English Proficient (LEP). The majority of the students live within the school's zoning, but the Montessori charter program allows any student in the district to apply for admission. The Montessori classes give priority to students already living within the regular zoning boundaries. The rest of the seats are filled through a lottery process. In 2011-2012, the year of the study, the school received a Magnet school status that allowed students to apply through the district. This may have caused a change in the student population, but that information was not available at the time of the study.

Table 2

Student demographics (2010-2011)

	Students
Hispanic	66%
White	23%
African American	8%
American Indian	<1 %
Asian\ Pacific Islander	<1 %
Reported Multiple ethnicities	3%

Montessori Charter

In addition to serving the neighborhood children in traditional classrooms, Openwood Elementary School has a Montessori charter program that serves students from across the school district. Students interested in the Montessori program must submit an application a year in advance. Priority is given to students in the neighborhood school zone, and then the rest of the names are selected based on a lottery system. If selected, the parents must agree to keep their students in the Montessori classroom for three years. They also agree to make two yearly class observations of their child and to participate in volunteer hours throughout the year. However, according to the principal, there is no way to enforce these requirements.

Montessori classes focus on developing the whole child and use many of the materials created by Maria Montessori. Openwood's program is an Americanized Montessori program, meaning that the teachers are able to be flexible with the Montessori curriculum to ensure that students are prepared for state and national grade level testing. This includes incorporating materials and resources that may not be found in a traditional Montessori class.

The Montessori program starts with children at 3 years of age, but children in grades younger than kindergarten are charged a fee to attend. Students in this age group can apply for financial aid from community partners that support the school's program. The school also received a grant to expand the Montessori program over the next three years, so that the school will gradually become a completely Montessori campus, with no traditional curriculum classes. At the end of the 2009- 2010 school year, all of the teachers were given the opportunity to begin the process of training and switch to a Montessori classroom. If teachers opted to make the switch and committed to teach in the district for 3 years after the training was complete, the school district paid for all of the Montessori training. This training included an intensive summer long professional development, as well as follow-up observations throughout the school year. In 2011-2012, the year of the study, the school had 20 Montessori classrooms and only 9 traditional curriculum classrooms.

Technology Resources

The school contains one computer lab with 27 laptop computers. Although these are laptops, they remain in the lab at all times so that they can be plugged in for internet access. The school's wireless router will not support more than 13 computers at once. Each classroom also contains three to five computers and a document camera. One fifth grade classroom also has a class set of laptops for their exclusive use. These laptops are used only in this class plugged into numerous routers instead of as a mobile lab because the school's wireless network will not support internet connections on a full class set of laptops at the same time. Two years prior to the study, the fifth grade students started

using the computers for an online math program. On his own initiative, the 5th grade teacher bought and connected routers within the classroom to accommodate the full set of laptops for his students. This teacher no longer teaches 5th grade math, but left the wireless capabilities intact in the classroom for the new teacher.

There is one computer lab on the campus. Previously, the lab was available for teachers to use, but there was no technology support on campus. District support was available, but they were slow to respond to problems with the computers. The principal reported that the lab was rarely used. In the 2011-2012 academic year, a technology specialist was hired to teach ancillary classes in the computer lab. This is the first year that technology has been included as an ancillary class. The ancillary classes serve as the regular classroom teachers' planning period.

During the 2010-2011 school year, the principal began a 2-year technology integration leadership training program. Through that training, an evaluation of technology integration on the Openwood campus was rated at a novice level. The leadership program pairs principals within the state with mentors to help them create and implement a technology plan on their campus. The mentors are other principals or district officials who have had success integrating technology on their campus. The lesson study professional development that was the basis for this research is one component of Openwood's technology integration plan that developed from the principal's participation in the technology leadership program. The details of the specific lesson study professional development that was used are described later in this chapter.

In addition to the push from the principal, the Parent Teacher Organization, PTO, has also decided that there is a need for more technology integration in the school. They decided to dedicate their fundraising efforts in 2011-2012 to adding more technology resources in the school.

Participants

All K-6 teachers were invited to participate in the lesson study professional development with their planning teams. The planning teams were determined by the school ancillary class schedule and changed once during the semester. The teams were made up of teachers teaching similar grade levels; however, because of the multi-age nature of classes some teachers in the group were not teaching exactly the same grade level. Each team consisted of three to five members. One teacher from each of the grades was selected by the grade level team as the lesson study facilitator. The facilitator was supposed to keep the team on track during the lesson study process and teach the research lesson during the process. This person was usually the grade level team leader.

Instruments

Although this study is qualitative in nature, some selected surveys were intended to be used to aid in the selection of research groups. The survey information was also intended to afford triangulation with interview and observation data when creating individual teacher profiles and group cases.

As shown in Table 3, the actual use of the survey data was not possible due to circumstances which are explained in the next section of this methods description. They are described below for the reader's information only.

Computer User Self-Efficacy Scale (CUSE)

The Computer User Self-Efficacy (CUSE) Scale (Cassidy & Eachus, 2002) measures individuals' self-efficacy with computers. Although there are several scales to measure this construct, many focus on specific computer programs or specific populations. The CUSE was intended to be used with an adult student population. As teachers in professional development are adult learners, it would be appropriate for use with them. Additionally, this scale was chosen because it includes items about computer use in learning situations. This scale was to be used both as part of the selection criteria for the lesson study group analysis and as a component of the individual teacher profiles.

Technology Beliefs and Competencies Survey

The Technology Beliefs and Competencies Survey was developed to assess pre-service and in-service teachers participating in the Preparing for Tomorrow's Teachers to Use Technology (PT3) initiative as part of a teacher preparation program at Arizona State University (Brinkerhoff, Ku, Glazewski, & Brush, 2001). Two different versions of the instrument were developed for pre-service and in-service teachers, but both versions included an identical section addressing the teachers' beliefs about technology as an educational tool. In teacher training, as with any learning, motivation is an important factor. Unless teachers see technology as an important instructional tool their ability to integrate technology effectively into their own classroom will be affected. This scale was to be used both as part of the criteria for selecting lesson study groups for analysis and in the individual teacher profiles.

The Technology Beliefs Survey is comprised of eleven self-report Likert scale items. Teachers rate their level of agreement with items such as "Incorporating technology into instruction helps students learn" and, "Content knowledge should take priority over technology skills" (Brinkerhoff, Ku, Glazewski, & Brush, 2001, p. 4).

Teaching Philosophy Survey

The teaching philosophy survey contains items selected from a national teaching survey developed by Becker and Anderson (1998). The Teaching, Learning, and Computing Survey-1998 was designed to gain insight into teachers' philosophies about teaching, teaching practices, and their use of technology (Becker & Anderson, 1998). The selected items that were to be used in the current study measure a teachers' philosophy based on two opposing theories of learning. The first, traditional transmission instruction, is based on the theory that "students will learn facts, concepts, and understandings by absorbing the content of their teacher's explanations or by reading explanations from a text and answering related questions" (Ravitz, Becker, & Wong, 2000, p. 3). In constructivist-compatible instruction, "understanding arises only through prolonged engagement of the learner in relating new ideas and explanations to the learner's own prior beliefs" (Ravitz, Becker, &Wong, 2000, p. 3).

Technology Integration Assessment Rubric

Harris, Grandgenett, and Hofer (2010) developed the Technology Integration Assessment Rubric to assess the quality of technology integration in a way that does not make judgments about the pedagogical approach, but rather evaluates the "fit" of technology within a lesson. The rubric evaluates lesson plans on four criteria using a four

point rating scale: curriculum goals and technologies, instructional strategies and technologies, technology selections, and "fit" (Harris et al., 2010). Appendix A shows the complete rubric. Each of the criteria corresponds to one of the four technology-related knowledge areas within the TPACK framework that forms the basis for this study.

During its development the rubric was reviewed and edited by six educational technology scholars at different institutions to assess its construct and face validity. Then, seven experienced technology-using teachers and district-based teacher educators independently graded three pre-service teacher lessons plans (from a total of 15 different lesson plans) to provide feedback and determine the reliability of the rubric. Each of the raters attended a rubric training session prior to grading the lesson plans. After revisions based on those results, a second group of eight raters was trained and rated the pre-service teachers' lesson plans. One month after the original ratings, all of the raters were asked to rerate their three lesson plans to establish test-retest reliability.

A total rubric intraclass correlation coefficient of 0.86 was calculated for the second group of raters using the revised rubric (Harris et al., 2010). Intraclass correlations for each of the rubric criterion were also calculated separately: curriculum goals and technologies (ICC= 0.82), instructional strategies and technologies (ICC= 0. 80), technology selections (ICC=0.83), and "fit" (ICC= 0.78) (Harris et al., 2010). Raters' percent agreements on all of the criteria were high as well, ranging from 84.1 percent on the total rubric to 93.5 percent on the curriculum goals and technologies criterion. The internal consistency of the final rubric was 0.911 and test-retest reliability was 87 %.

The Technology Integration Assessment Rubric was used to determine the quality of technology integration in the teacher lesson plans and class observations. Lesson plans were collected from teachers prior to and post lesson study cycle. Class observations took place at unscheduled times and lasted between 30 and 60 minutes.

Semi-structured Interview Questions

Participating teachers answered semi-structured interview questions prior to the beginning of the lesson study cycle (Appendix B) and at the end of the first semester (Appendix C). The interview questions focused on four main topics: 1) the teacher's philosophy of teaching, 2) the teacher's attitudes toward technology, 3) the teacher's use of technology, and 4) their experiences with lesson study professional development. The interviews lasted 30 to 45 minutes and were audiotaped. All audiotapes were transcribed and erased. Transcripts were coded using the TPACK codebook (Appendix D) and other open codes (Appendix E).

Procedures

Due to the nature of working within an actual school setting, some changes were made in the procedures throughout the course of the study. This section describes both the proposed procedures and the actual procedures. Table 3 shows an overview of the proposed procedures and the actual in school process. Implications of any procedural changes will be discussed in the Chapter 4.

Table 3

Comparison of proposed and actual study procedures

Procedures	Proposed	Actual
Participant Recruitment	Half-Day whole school training	30 minute meetings with grade level teams
Teacher Pre-Surveys	All teachers complete surveys online.	Only one teacher pre-survey was completed.
Teacher Pre-Interviews	All teachers interviewed for 30-60 minutes.	Consenting teachers for LSPD Phase I interviewed for 30-60 minutes.
LSPD Phase I-Facilitator Training	60 minute training with teacher facilitators.	10-30 minute meetings with teacher facilitators.
LSPD Phase I	2 or 3 teacher teams complete LSPD in 1st nine weeks.	1 teacher team consented to LSPD and started in the 1st nine weeks, continued LSPD into the 2nd nine weeks.
Phase I-Post Interviews	All teachers from Phase I interviewed at the end of the 1st nine weeks	Post Interviews moved to the end of the 2nd nine weeks.
LSPD Phase II-Facilitator Training	60 minute training with teacher facilitators.	10-30 minute meetings with teacher facilitators
LSPD Phase II	2 or 3 teacher teams complete LSPD in 2nd nine weeks	2 teams consented to LSPD in the 2nd nine weeks, but both teams were unable to complete the process.
Phase II-Post Interviews	All teachers interviewed for 30-60 minutes.	Post-interviews were conducted with all consenting teachers
Post Surveys	All teachers complete online post surveys.	No teachers completed the post-surveys

Participant Recruitment

Although all teachers at the school were told that they would participate in the lesson study professional development as part of a new initiative, only consenting teachers were interviewed and asked to complete the surveys. Teacher participants were recruited during the beginning of year teacher training or during their weekly team planning meetings. They all received a copy of the consent form that was approved by both the University of Texas Institutional Review Board and the school district's review board.

Teachers participated in the lesson study professional development in two phases in order to scale-up the professional development slowly. The first phase took place during the first nine weeks and the second phase started in the second nine weeks. All teachers were intended to be participating in the lesson study professional development by the second phase. During phase one, two grade level teams were to complete the lesson study cycle. These teams were chosen by the school principal, because she felt they would be the most open to technology integration. Interviews, class observations, group meeting participation, and teaching artifacts were collected from all of the consenting teachers in these groups. In the second nine weeks of the school year (phase 2), all grade level teams were asked to implement the lesson study professional development. In this second phase, three additional teacher groups were added to the lesson plan professional development, but only two of the groups consented to the study.

Only consenting teachers participated in the pre- and post- surveys and observations. All teachers in the chosen grade levels were audiotaped during their lesson plan cycle meetings, but comments and responses from teachers who did not consent were not included in the transcripts or data analysis. The audiotapes were erased once data collection and analysis were completed.

Lesson Study Process and Protocol

The lesson study process was designed to be conducted and completed by each group of teachers in nine weeks. Appendix F shows the intended timeline of the process including the training of teacher facilitators. During pre-service teacher training days all of the teachers were to be introduced to the idea of lesson study professional development

in a whole school meeting and grade level facilitators would be chosen. During this training phase, I had planned to give facilitators a half-day training outlining the goals, process, and outcomes of the lesson study professional development. The chosen teachers would then be responsible for facilitating the lesson study professional development with their grade level. However, due to time constraints and other mandatory meetings, the principal asked me to meet individually with teacher groups to introduce them to the lesson study cycle. I met with two teams during the pre-service training days to discuss the lesson study process. One group consented to the process and to participate in the study. This group also chose a facilitator to discuss the lesson study process outlined in the facilitator guide (Appendix G). I met briefly with the facilitator, but did not conduct the full half-day training. The second team of teachers refused to do the lesson study cycle, even though they were told it was a school-wide professional development that all teams were expected to complete. They also refused to participate in any part of the research study.

The proposed lesson study cycle consisted of at least 4 group meetings and one group class observation. The ideal flow of the cycle is described below.

Meeting 1. In the first meeting, teachers establish group norms and decide on a specific learning objective or group of related objectives for their group lesson. The learning objective should be one that past students have found difficult to master or that current students are struggling to grasp. The group must come to consensus about the learning objective or objectives. These decisions should be based on past or present

student grades, test scores, benchmark scores, informal assignments, or teacher observations.

Meeting 2 and observation. The second group meeting focuses on designing the lesson. Teachers are responsible for brainstorming and researching different technologies and ways to teach their chosen learning objectives prior to this meeting. In the second meeting, the teachers collaborate to develop a lesson using the template in Appendix G and choose which teacher will model the lesson in a real classroom. The teachers also assign different aspects of the lesson for each teacher to focus on during the observation (i.e., student questions, timing of activities, student interactions). Each teacher is to focus on a different aspect, but none of them should focus directly on the teacher being observed. The purpose of the observation is to critique the team-created lesson and its impact on students' learning, not the individual skills of a teacher.

Meeting 3. The third meeting should take place within one to two days of the observation lesson. During this meeting, the teachers debrief about their observations of the lesson. If the lesson did not go well, they can choose to revise the lesson and conduct another observation lesson in a new teacher's class. If the lesson was successful or needs only minor revisions, the teachers can tweak the lesson and conduct it in their own classes.

Meeting 4. After all teachers have taught the lesson, they meet to write a group reflection of their lesson. The reflection should include the learning objective(s), the reason for choosing those objectives, the lesson plan and any revisions, observation lesson feedback, and reflections about the process and what the teachers learned.

Data Collection

Data collection was scheduled to take place in three phases corresponding with the phase of implementation of the lesson study professional development at Openwood Elementary school.

Training phase. The proposed training phase was to happen during the week of August 15th through 19th, 2011 while the teachers have scheduled professional development. Two types of data were scheduled to be collected from the teachers during the training phase. First, all teachers were to be given a compiled online survey including the Computer User Self-Efficacy (CUSE) Scale (Cassidy & Eachus, 2002), the Technology Beliefs Survey (Brinkerhoff, Ku, Glazewski, & Brush, 2001), and the Teaching Philosophy Survey (Becker & Anderson, 1998). Teachers were to be given a week to complete the survey on their own time online. Additionally, all consenting teachers were to be interviewed for at least 30 minutes, and no more than 90 minutes, regarding their beliefs about technology and teaching (Appendix B).

Since the Lesson Study professional development was not introduced to the whole school, only the teachers in recruited groups were given the pre-survey and pre-interview at this time. All other consenting teachers were given the survey and the interview at the beginning of the second nine weeks after they received the training on lesson study professional development.

The interviews were scheduled before and after school and during teacher planning periods at the convenience of the teacher.

Data collection: Phase I. Phase one was scheduled to take place during the first nine weeks, August 22, 2011 through October 14, 2011, of the school year, but the lesson study professional development was delayed several times so data collection lasted the entire first semester. Phase I only included teachers from the two teacher teams that were selected by the principal. In Phase I, I observed and audiotaped all of the lesson study group meetings. I typed field notes and reviewed the audiotapes as soon as possible after the observation. Additionally, I created transcripts from the audiotapes of teacher meetings. I also conducted class observations for all consenting teachers. The observations were collected prior to, during, and after the lesson study cycle. A running record was kept for each of the class observations and I used the Technology Integration Assessment Rubric (Harris, Grandgenett, & Hofer, 2010) to assess the lessons that contained some form of technology. I also tried to collect artifacts from the lesson study professional development, such as the completed lesson plan template, lesson plan revisions, and teacher observation notes, and the reflective write-up. Some of these artifacts were not completed and the others were lost before I was able to get a copy.

Data collection: Phase II. Phase II occurred during the second nine weeks of school, October 17, 2011 through December 16, 2011. Prior to the school year, the principal had said that all K-6 teachers would be required to participate in the lesson study professional development. However, several teams refused to participate in the lesson study professional development. No steps were taken by the principal to ensure that the teams participated. Therefore data were collected only from the teams that agreed to participate in the lesson study professional development and consented to

participate in the study. Again, all of the lesson study group meetings were observed and audiotaped. I also conducted class observations with consenting teachers. These observations were collected prior to and during the lesson study cycle. Neither of the teams completed the lesson study cycle, so observations were not done after the end of the lesson study cycle. I wrote field notes for each of the observations and used the Technology Integration Assessment Rubric (Harris, Grandgenett, & Hofer, 2010) to assess the classroom lessons that contained technology. I also attempted to gather teacher lessons plans from consenting teachers. Since the groups did not complete the lesson study cycle, there were no other artifacts collected.

At the end of Phase II, all consenting teachers were sent the online survey and asked to participate in a 30 minute post-interview (Appendix C). Teachers were able to complete the online surveys at their own convenience. The interviews were scheduled before or after school and during planning periods to accommodate the teachers' schedules.

Research Questions

The purpose of this study was to understand the experiences of teachers in a lesson-study professional development designed to enhance technology integration. For this reason, I adopted a qualitative approach (Yin, 2009).

Research Question 1

How do teachers in a technology-infused lesson study group develop a) in their attitudes toward technology and b) technological pedagogical content knowledge (TPACK)?

Rationale 1. Lesson study professional development allows teachers with differing levels of knowledge and experience to learn from one another through modeling and dialogue. The final step in the lesson study process involves writing a reflective report documenting the lesson, the materials used, and insights into what the group learned through the process. Including technology in this process may help teachers experience technology in a safer environment. Teachers also get the opportunity to see the technology being used in a real classroom. This allows teachers to build their self-efficacy with the technology without having to do it alone.

Data sources 1. This research question was analyzed using the teacher survey data and teacher interviews. I created teacher profiles for each consenting teacher to examine changes from the beginning to the end of the lesson-study process. A constant-comparative method was used to look at patterns among the different participants (Corbin & Strauss, 2008).

Research Question 2

How do teachers in a technology-infused lesson study group change their lesson planning and teaching behaviors?

Rationale 2. In the professional development, teachers were exposed to the planning decisions of other teachers in their grade level. They also were to observe other teachers' classes on the co-authored lesson plan. Finally, teachers were asked to conduct at least one lesson that incorporates technology with their students. All of the situations could lead to a change in the teachers' planning and teaching outside of the group.

Data sources 2. Teacher lesson plans, class observations, personal interviews, and interview data from other teachers were used to analyze this research question. In the interviews, teachers reported on their own teaching practices and any changes that they saw in their group members' practices. By triangulating these data with lesson plans and class observations, I was able to look for changes in teacher's behaviors.

Research Question 3

Were there features of the group that played a role in the teacher's development?

Rationale 3. The teacher experiences undoubtedly vary based on the characteristics of the teachers in their group. Each group contained teachers with a variety of prior experiences teaching and teaching with technology. This diversity of views could lead to differing outcomes in the lesson study groups.

Data sources 3. Using the teacher profiles created for the first two questions, I used the constant comparative method to analyze patterns in teacher change in relation to group characteristics. These characteristics included grade level and content area chosen, as well as the skills, knowledge, and attitudes of the teachers within the group. Audiotapes and field notes from group meetings were used to look for characteristics that are different or similar in the groups, especially in the functioning processes of each group.

Data Analysis

Data Sources

Several data courses were used to analyze the data in this study. The purpose of each data sources is discussed below. As with the procedures, the proposed data sources were not always available once in the school setting. Table 4 provides an overview of the data collected.

Table 4

Data collected from study participants

	Teacher Teams					
Data Sources	**1**	**2**	**3**	**4**	**5**	**Total**
Pre-Surveys	1	0	0	0	0	1
Post Surveys	0	0	0	0	0	0
Pre-Interviews	5	2	3	0	0	10
Post Interviews	5	4	3	0	0	12
Teacher Lesson Plans	4	1	0	0	0	5
Classroom Observations	19	10	10	2	1	42
Group Meeting Recordings	12	8	1	0	0	21
LSPD Lesson Plan	1	0	0	0	0	1
LSPD Reflection	0	0	0	0	0	0

Survey results. Descriptive statistics calculated from each of the pre- and post-surveys were intended to be compared with the interview data to better understand the teacher's responses, using pre- and post- scores on individual surveys will be used to look at teacher's change from the beginning to the end of the lesson study cycle. Pre- scores were also intended to help in the selection of groups for further analysis. However, only one teacher completed the pre-survey, and none of the teachers completed the post survey. Due to the lack of participation on these measures, they were not used in the final analysis or group selection.

Interview transcripts. All pre- and post interviews were transcribed for analysis. First, I read the complete transcript to make general notes about the tone and themes. Then I coded the transcripts using a combination of open coding and pre-established TPACK codes (Appendix E) when applicable. Information about the teachers' attitudes and practices is included in the teacher profiles to provide more insight into the survey data. A peer reviewer coded samples of the transcripts to verify the a priori and emerging themes. Additionally, I met with a peer reviewer to discuss problem areas in the coding.

Lesson plans. Lesson plans were collected from the teachers for the entire period of their lesson study cycle. Teachers participating only in the second lesson study cycle turned in lesson plans for the two weeks prior to the start of their cycle. I counted the number of times that technology resources appear in the lesson plans and chart that number over the course of the lesson study cycle. Additionally, lesson plans that include technology were selected and reviewed using the TPACK rubric (Harris et al., 2010). The rubric rates the effectiveness of the technology integration.

Class observations. In order to check the fidelity of the lesson plans and to gather richer information, I conducted classroom observations periodically throughout the semester. I took running record field notes during the observations and used the TPACK rubric (Harris et al., 2010) to assess fit of technology integration in the classroom. When relevant, this information is included in the teacher profiles.

Group meeting transcripts and field notes. I recorded and observed all of the teacher meetings during the time that they were participating in the lesson study professional development. While attending the meeting, I wrote field notes about the

number of attendees, tone of the meeting, and progress of the group. I reviewed all recording and wrote memos about the teacher discussions. For meetings pertaining directly to the lesson study professional development, I transcribed and analyzed the audiotapes to look for evidence of TPACK mentioned in the teachers' reasoning during the meetings. This information was combined with the teacher profiles to create the lesson study group cases.

Group lesson plans and reflective documents. During the course of the technology-infused lesson study, the groups should have written a reflective document including the groups' goals, the lesson plan, and reflections about the lesson in action. I had proposed to analyze the group lesson plan using the Technology Integration Assessment Rubric (Harris, Grandgenett & Hofer, 2010), however I was not able to collect this lesson plan from any of the teacher teams.

Teacher profiles. A teacher profile was constructed for each consenting teacher. This profile includes their pre- and post- survey scores, summary analysis from their interviews and lesson plans. Other group members' perceptions of the teacher's development are also included in the teacher profiles. These profiles were used in constructing the lesson study group cases that were analyzed for each research question.

Lesson study group cases. The final stage of analysis was creating case studies of each of the lesson study groups. Three group cases were compiled from the teacher profiles, as well as from analysis of the group meetings and group created products (Yin, 2009). The constant comparative method was used to look for differences and similarities in the teachers' within each lesson study group and between the four different

groups (Corbin & Strauss, 2008). Themes were examined across the three case study groups.

Trustworthiness

Guba (1981) described four components of trustworthiness in qualitative research: credibility, transferability, dependability, and confirmability. These four concerns relate to various aspects of rigor in the rationalistic paradigm. The credibility deals with the match between the findings and the actual phenomena those findings represent and corresponds to the idea of internal validity. External validity and generalizability are better described as transferability in qualitative research and relate to whether or not one's findings will be applicable to broader settings. Dependability occurs when findings are consistent over time and in replication studies. This concern replaces reliability in quantitative research. Confirmability is the final concern in establishing trustworthiness in qualitative research. The term replaces objectivity in the rationalistic paradigm. In qualitative research, the researcher does not remain removed from the data analysis process and must guard against researcher bias. Below I describe how I incorporated these concerns into my data collection and analysis.

Credibility. I took several measures to establish the credibility of the research findings. My presence at the school may have affected the actions of the teachers both in their teaching and in their participation in the lesson study professional development. However, prolonged engagement and persistent observation can alleviate some of the "distortions produced by the presence of researchers and [provide] the researchers the opportunity to test their own bias and perceptions, as well as those of their respondents"

(Guba, 1981, p84). I visited the school on a regular basis throughout the course of a semester, spending multiple full school days in classrooms and teacher meetings in order to interact with and better understand the teachers. I conducted a minimum of two pre-observations and two post-observations with each of the teachers selected for case study analysis.

Triangulation is another technique that can increase the credibility of a study. Guba (1981) stated that "no item of information ought to be accepted that cannot be verified from at least two sources" (p.85). Multiple surveys, interviews, observations, and written artifacts were collected from the teachers. In my analysis, I used these multiple sources to confirm all of my findings, accepting only those conclusions that were supported by triangulation of the data.

Peer debriefing involves allowing other researchers to review my coding and my thought processes during the data analysis phase. In addition to discussing my findings with both of my co-chairs, I had a peer debriefer code data samples for comparison with my own coding. This peer debriefer was also consulted when I encountered problematic data, or data that may drastically change the direction of my analysis.

Transferability. In qualitative research, transferability is achieved by providing a thick description of the setting and the participants. I have described the school and teachers in as much detail as possible without revealing the identity of the participants. The rich description allows readers enough information to determine the extent to which they can expect to have similar findings at their sites.

I intended to use theoretical sampling to choose my lesson study groups in order to have the greatest degree of variation in the data analysis. The pre-surveys on technology beliefs, technology efficacy, and constructivist teaching beliefs would have allowed me to choose grade level teams with differing compositions in order to gain a variety of viewpoints and experiences in the lesson study professional development. However, due to the nature of conducting research in a real school setting, I was unable to get enough participants for this type of sampling. The cases presented are based on a convenience sample of the teachers who consented to the study.

Dependability. The use of multiple overlapping data sources increases the dependability of my findings. In addition to using multiple sources, I created an "audit trail" so that others are able to examine my analysis process. "The audit trail takes the form of documentation (the actual interview notes, for example) and a running account of the process (as in the form of an investigators' daily journal)" (Guba, 1981, p. 87). In addition to cataloging all of my field notes and interview transcripts by date, I wrote memos after each data analysis session. These are organized by date and category so that others can follow my thoughts and decisions throughout the process.

Confirmability. The multiple data sources and audit trail can also be used to establish confirmability. In addition to these techniques, I practiced reflexivity prior to and throughout the data collection and analysis. This involved revealing my "underlying epistemological assumptions which cause [me] to formulate a set of questions in a particular way, and finally to present [my] findings in a particular way" (Ruby, 1980). The first part of this is revealing any potential biases to the reader prior to data collection.

The following section, positionality, will reveal those biases as I understand them at this point. In addition to initial bias, I included notes about my feelings, perceptions, and assumptions in memos as I proceeded with data collection and analysis. This information is included in my audit trail.

Positionality. In all qualitative research the data collection and analysis are filtered through the lens of the researcher. The researchers' "autobiography and identity-life experiences, knowledge, training , emotions, values, attitudes, beliefs, gender, ethnicity, and so forth- influence and affect how [they] navigate through the enterprise and approach other important elements, such as the relationship between [them] and [the] participants and the analysis of [their] data. " (Saldana, Leavy, & Beretvas, 2011, p. 22)

In 2005, I received my alternative teacher certification in conjunction with Teach for America and was sent to Houston to teach. I taught fourth grade for two years in the Houston Independent School District and one year in the Austin Independent School District. One of my assistant principals is currently the head principal for my study site. While teaching in Houston, I had three computers in my classroom, access to a computer lab, and on-site technology support staff. My students also went to a computer lab class at least once a week. At this school, I used computers in the classroom mostly for the purpose of showing video clips, practice drills, and reading comprehension quizzes. In Austin, I also had three computers in my class and access to a lab. However, there were no technology support personnel at my campus, and my students did not have any computer classes. My students used the computers for occasional math drill practice and to type stories and essays they wrote in class.

After teaching, I started graduate school interested in teacher training and support. I became more interested in technology as I began to question my own personal use of technology in the classroom. I am comfortable with technology, use it frequently in my personal life, and see value in students being able to use technology. However, as a teacher, there was very limited use of technology in my teaching.

Over the past two years, I have studied the effectiveness of clickers in the college classroom and participated in several in-depth case studies of technology integration in middle schools. I think that technology can be a powerful tool in the classroom when it is used to support effective pedagogy. I am aware that these experiences and biases may not be typical of all teachers or researchers. I kept a thorough journal of my thoughts and decisions to guard against severe biases in my data collection and analysis.

Chapter 4: Results

The results of this study are organized as teacher group case studies. Each case discusses the members in the group and the team's progress with lesson study, as well as any other contextual factors about the group meetings or their participation in lesson study. Within each case, the answers to the three main research questions are examined.

1. How do teachers in a technology-infused lesson study group develop (a) their attitudes toward technology and (b) their technological pedagogical content knowledge (TPACK)?
2. How do teachers in a technology-infused lesson study group change their lesson planning and teaching behaviors?
3. Were there features of the group (such as membership, grade level, subject matter, group interactions, etc.) that played a role in the teachers' development?

A final cross-case analysis explores the themes that emerge across the three teams, focusing on the initial research questions.

Although five teacher groups were told that they were required by the principal to complete lesson study professional development as part of their professional development, only three teams consented to participate in the professional development. Table 5 shows the five teacher groups and their characteristics. Teams 1, 2, and 3 agreed to participate in the lesson study professional development. All but one of the teachers in these three teams also consented to participate in the study. Teachers in Teams 4 and 5 were also asked to complete the pre and post interviews and submit to classroom

observations. Only one teacher in these two groups consented to the surveys, interviews, and observations. She was observed, but was unavailable for either of the interviews. Ultimately, only three teams were part of this study in which data were collected, analyzed, and reported.

Table 5

Teacher groups at Openwood Elementary

	Focal Research Cases			**Cases Not Studied**	
	Traditional Early Ele. (Team 1)	**Montessori Early Ele. A (Team 2)**	**Traditional 4/5 (Team 3)**	**Montessori Early Ele. B**	**Montessori Upper Ele.**
Teachers (#)	6	4	4	4	3
Consenters (#)	6	4	3	1	0
Researcher role in PLC Meetings	Attended all meetings during 1st & 2nd nine weeks (12 meetings total)	Attended all 2nd nine weeks (8 meetings total)	Attended 1 meeting during 2nd nine weeks (This group had meetings off-campus and they freq. did not tell me that they were meeting.) (1 meeting total)	Attended most meetings 2nd nine weeks, but did not record most of them due to the low number of consenters. I did take field notes.	Attended 1 meeting. Did not record
Interviews Obtained	All teachers participated in at least 1 interview (5 pre, 5 post)	All teachers participated in at least 1 interview (2 pre, 4 post)	3 teachers participated in pre- & post interviews (3 pre, 3 post)	No interviews	No interviews
Teacher Lesson study accomplishments	Planned and executed research lesson. Revised and re-taught the research lesson.	Attempted to start several times, never got past the first step.	Agreed to do lesson study, but never discussed it in meetings.	Refused to participate in study, resistant to the lesson study PD, never started.	Refused to do the lesson study PD in both the 1st and 2nd nine weeks.

The sections present the results from each of the three case studies. Each section begins with a description of the team members followed by the analysis of their progress and experiences in the technology- infused lesson study professional development.

Traditional Early Elementary Team (Team 1)

The traditional early elementary team (see Table 6) consisted of five classroom teachers and one student teacher: Abigail, Bridgette, Christopher, Deborah, Emily, and Frances. All of the teachers in this group used a traditional public school curriculum and teach students in 1st to 3rd grade. Two of the teachers in the group, Bridgette and Emily, were mid-career teachers, while the other three teachers each had over 25 years experience in education. This group was one of three groups chosen by the principal to start lesson study professional development in the first nine weeks of the school year. All of the team members consented to the study because they a) wanted to help me with my dissertation and b) at this point in the year, lesson study professional development was a whole school requirement.

The next sections give a detailed description of each teacher's philosophy of teaching, beliefs about technology, and use of classroom technology before the start of the lesson study professional development.

Table 6

Traditional Early Elementary Teachers

	Deborah	Bridgette	Abigail	Christopher	Emily	Frances
Grade Taught	2nd/3rd	2nd/3rd	1st	2nd/3rd	1st/2nd	1st/2nd
Years Experience						
Veteran (15+)	*(20+)		* (25+)	*(30+)		
Mid-Career (6-15)		* (6)			*(7)	
Novice (0-5)						* (0)
Available Classroom Computers (#)	5/7[1]	3	6	5	4	NA
Reported Classroom Technology Use						
Audio Tape/CD player		X[2]			X	
Projector/ Elmo		X	X	X	X	
Educational Software	X	X	X	X	X	
Educational Website	X		X	X	X	
Computers for Research				X		
Microsoft Word						
Microsoft Power Point					X	
Blogs						
Assessment Software						

[1] This teacher had a different number of computers in her classroom at different times of the year.
[2] X means that the teachers reported using this type of technology in their classrooms.

Team 1 Teacher Profiles

The teachers in this group all used a traditional public school curriculum and taught students in 1st to 3rd grade. Some of the teachers have only one grade level, but many of the teachers have multi-age classes. Since the school is moving to a Montessori curriculum, all of the teachers were given the opportunity to begin the process of training and switch to a Montessori classroom. All of the teachers in this team choose not to take the Montessori training. The teacher profiles are constructed from pre- and post-interview data, classroom observation data, group meeting observations, and lesson plans when available.

Deborah. Deborah was the team leader. She had a Ph.D. in education and had done several jobs within the school district. She had experience teaching all grade levels

from kindergarten to middle school, focusing mainly on math and science. Additionally she worked as a computer trainer, wrote teacher grants, and directed student competitions. After downsizing at the district level, she had returned to the classroom. This was her second year at Openwood. In the previous year, she had taught the music ancillary class. During the year of the study, she taught math and science to 2nd and 3rd grade students. Her students took reading, writing, and social studies from Bridgette.

At the beginning of the year, she seemed overwhelmed by the amount of things she needed to do for her classroom. She brought in help to get her classroom organized and asked me to help set up her computers. This sense of urgency to get through all of the requirements of her job continued throughout the semester. She even multi-tasked during her interviews. In the pre-interview, she made photocopies and organized her classroom. The post-interview was conducted while she was monitoring an afterschool program.

In the classroom Deborah saw herself more as a facilitator, but appreciated the fact that a teacher's role can change based on the situation. She stated, "I see myself as more of a facilitator more than I see myself as a giver of information, although I know it has to start somewhere. I think your role as a teacher, my role as a teacher, changes from time to time depending on what the student needs" (Pre-interview). In her teaching, she tried to encourage higher-order thinking skills with all students. She described this when I asked about a typical lesson.

> My lesson begins before I'm ever with the kids, because I'm kind of thinking about what's going to make the kids think higher. So I look at

> the [standards] first, and I see what it is I'm supposed to be teaching. Then I think about is there a creative way to communicate that without the textbook or with the textbook. (Pre- interview)

She went on to discuss the importance of asking questions to monitor student progress. Deborah used this information to remediate with struggling students. She did this individually or by partnering higher students with struggling students together to help them understand a specific concept. Both of these strategies, frequent questioning and pairing students, were observed on several different occasions (Field notes: August 29, September 9, November 30, 2011). In these observations, she did not have her students work in small groups or stations like some of her peers. In the following quote, she explained her reasoning for this:

> I'm probably very old fashioned. I think my job is to deliver the instruction. I think sometimes that means facilitating, but I'm not a strong proponent of small group, except for the purpose of remediating. The stations, I think, from what I've observed in other classrooms and in my own at times, stations don't seem to move kids along very much, so I think I'm very much a direct instruction teacher. (Post Interview)

Deborah had previously "taught computers for 10 years" and felt "very proficient" with technology (Pre-interview). While helping her arrange her computers, I found that she had at least three routers and numerous computers cables. She also had several small CD players. I did not see her use these, but I

know that she lent them to other teachers for use in their classes. Deborah had two or three other boxes in her closet, but I was not able to explore those materials. I think that those boxes contained other technological equipment, but it was never taken out of the closet or used. At the beginning of the year, Deborah was adamant about getting more computers in her room. She knew that there were extra computers that needed to be distributed. Rather than waiting for someone to bring the computers to her, she got permission to get computers herself and to pass out computers to other teachers on her team. She gave one or two computers to Bridgette and put several in her own classroom. At one point, she had seven computers set up in her classroom. I never observed the students using these computers, and after about two weeks the principal made her give some of the computers away. The principal only allowed her to keep five of them.

Deborah felt that computers could be very beneficial for student learning, but did not think that she or the other teachers at Openwood had enough quality technology equipment in their classrooms.

> I think if we had good computers, I think it could do many things. I think it could be diagnostic. I think it could be reinforcement. And on certain skills, I think it could even teach lower students that you don't have time to teach. But, I think when you get these old, outdated, donated machines, um, it's very limited. I think what you're going to get there is, you're going to get practice basically. But it also requires that the teacher take a

lot of time organizing that, because you only have 2 or 4 computers and you have 20 kids. (Pre-Interview)

In the pre-interview she admitted that she was not using any technology in her classroom, but planned to use the computers as a station for reinforcement after she got more computers set up in her room. Before the interview she had only one or two computers. As mentioned earlier, she was able to get more computers in her room. Despite several observations, I never saw students using the computers in her class.

Deborah's motivation to participate in the Lesson Study Professional Development and the research stemmed from her desire to help me complete my dissertation. She always referred to lesson study as "Sara's project" and asked me several times what exactly her group needed to do in order for me to get the information needed to complete the research study. She seemed more concerned with this than actually completing the lesson study process.

Bridgette. Bridgette was in her sixth year of teaching. She was hired at Openwood Elementary directly out of school and had taught grade levels ranging from pre-kindergarten up to 3rd grade. This was her first year teaching 3rd grade, which was a high stakes testing grade level for reading. At the beginning of the year, she was supposed to teach a self-contained split class with 2nd and 3rd grade students. The school had three traditional curriculum teachers working at this 2nd/3rd split grade level. The other two teachers were supposed to departmentalize and switch classes. However, the third teacher was reassigned to serve as a reading intervention teacher due to low 2nd

and 3rd grade enrollment. Bridgette was assigned to the reading/language arts position in the departmentalized 2nd/3rd split with Deborah. This split allowed Bridgette and Deborah to arrange their students into two instructional groups: a 3rd grade class and a 2nd grade class. The students in the same grade level switched together so that each teacher had only one grade level of students at a time. This circumvented, perhaps unknowingly, the principal's purposeful assignment of split grade level classes to introduce the teachers and students to the type of multi-age classes that are practiced under the Montessori curriculum.

As a teacher, Bridgette saw herself as a "facilitator" who should "monitor their learning just to make sure they think independently" (Pre-interview). Students in her class were often walking around the room and working together on assignments. She expressed this philosophy in her interviews, and I observed these student actions on various occasions. She often referred to the students in the class as "friends" and encouraged the students to help each other. Even in interviews, she said that students would often read to their "friends" in the class (Pre-interview).

From the beginning, Bridgette reported feeling very comfortable with technology both inside and out of the classroom. She had a cell phone, iPad, and a personal computer at home. In the classroom, she had an Elmo projector, 3 computers, CD players, and a Leap Frog tablet. In her first interview she explained that she received technology training in her pre-service education classes and had tried to incorporate some of those technology activities into her teaching. She described a project that she had previously done in her class.

> Two years ago, I did a PowerPoint presentation with my second-grade students and my first-grade students and we were going on a field trip to the aquarium so we learned about sea animals and things like that. So we took pictures, we searched for those pictures and we put them together and we presented their presentations. (Pre-interview)

However, she had not repeated that type of project with her students in the last two years. She did say that she hoped to do something similar to that project in the future.

She stated that she currently used the Elmo projector and computers frequently. According to Bridgette, students worked on the computers using educational programs that the school and district had purchased. These programs tended to be self-paced programs that tracked student progress through frequent testing. Many of the programs included short lessons and reteaching activities for students who did not pass the tests for certain objectives. Despite her claims, I did not observe any technology use by Bridgette or her students in the five observation visits to Bridgette's classroom.

Bridgette had a difficult time adjusting to the stress of teaching a testing grade. She did not like the pressure and got defensive in one meeting where the principal was calling out individual teachers on their choice of instructional practices. In most meetings, Bridgette remained quiet during group discussions about the lesson study professional development and other school policies or requirements. However, she frequently brought up specific student and parent issues that she was struggling with in her class. She shared students with Deborah, but seemed willing to take suggestions from

all of the teachers in the group. When the benchmark testing was discussed in meetings, she became visibly stressed.

When asked about switching to Montessori, Bridgette said that she simply did not know much about the paradigm and was unable to commit to the time intensive training and district requirement. This may be partially due to the fact that she had a young child.

Abigail. Abigail had over twenty-five years of experience teaching early childhood and had worked at Openwood since 1987. This year was her first year teaching first grade and she experienced many adjustments due to this grade change. While she was able to keep many of her students from the previous year, she had to change the materials she was using and the layout of her classroom. She also had to adjust to a new curriculum and age level. She reported that:

> Probably the biggest adjustment though was having to give grades and have a set number of grades for every child. I have to have eighteen [grades] for the core subjects and nine for each of the other subjects. Honestly, there's lots of grades that I have taken, but I'm just shocked because they were so low. And you know they can't do a whole lot at the time, and [the principal] has a guide of what can be a quiz and what can be a test. So, I've really had to work my way through that, what I can use and what I cannot. I've done grading and re-grading and grading and re-grading as I've done re-teaching. (Post interview)

While grading was an issue for Abigail, she never mentioned the pressures of the benchmark testing or state tests. At the first grade level, her students did not have to take

the benchmark assessments, and had to take only one standardized test during the year. While their standardized test covered multiple subjects, it was not a new test and was not as high stakes as the tests given at upper grade levels. Teaching only first grade students insulated Abigail from the testing pressure.

In her teaching, Abigail tried to provide her students with lots of different learning experiences. She felt that by providing a variety of learning opportunities she was able to reach most of her students. As a teacher, she was responsible for tailoring these diverse experiences to her students' needs:

> I think my role as a teacher is to help children learn as much as they can, um, and to provide a lot of experiences for them. Um, I do believe in direct instruction. I think you have to have it, especially in early childhood, but I think that children have to have the time to work on their own and I am kind of like a guide or a facilitator walking around, watching children work or helping children figure out what to do next or helping children work with that center so that they can be successful. (Pre-interview)

For Abigail, computers were just one more type of learning experience that she could provide for her students.

Although she was an older teacher, Abigail felt strongly that technology was important for her students. Abigail regarded technology as a key component of a balanced education for her students. In this regard, she used computer programs on a regular basis to supplement her teaching. In the following comment, say explained her

reasoning for using computers. "I mean maybe there's some kids that don't learn from direct instruction. They just don't get it, but you put them at the computer with a program that's really a good program and they will get it" (Pre-interview). She was also aware that her students, even in first grade, were being exposed to lots of technology outside of school.

> Children are so media savvy today. I mean, they all have an X box or a whatever the newest one is. Many of them have their own telephones, which I find in kindergarten and first grade just amazing that they might have their own cell phones. Yes. I just find that amazing. Almost all of them have TVs and dvrs in their room; or if they don't have a dvr, they have a DVD player. (Pre-interview)

To keep up with the changing technology that her students encountered, Abigail has taken several technology courses and professional development workshops to improve her technology skills over the years. She was also proactive about obtaining and keeping technology in her classroom despite the challenge of limited resources. The following quote illustrates that she not only believed that technology was important for her students, but also strived to bring the most current technologies to her students.

> Well, I've always used technology. Even in the days of film strips and films, I was the teacher on campus who ordered the films from the Film Library and the other teachers always wanted to join my class to see the film, but they didn't want to order the film. Because they didn't want to have to go check out the film projector, they didn't want to have to put it

together, they didn't want to have to show it and if it broke, God forbid. So even with film strips and film projectors and of course, we've gotten way beyond that from language masters to listening posts now to computers, I think it's really important just to meet the needs of children as we move along through the years. (Post interview)

Abigail had six computers in her classroom, two of which were old Apple computers. She worked very hard to get and keep these computers in her classroom. In the pre-interview she told a story of how she begged to keep the Apple computers when the school updated to new computers. All of the other teachers had to give up their Apple computers in order to get the updated computers, but Abigail was able to keep the Apple computers and get the additional new computers for her students.

In her classroom, Abigail had three different stations setup for student computer use. Students used the different computers for different types of computer software or educational websites. Abigail's favorite software was a reading program that tracked individual student reading progress and adjusted the instruction and activities to the student's level. All of Abigail's students use this program on regular basis. She tried to have every child use the program daily. Abigail used the individual student reports in her grading and sent the reports home to communicate her students' progress with parents.

In observations, there were always students working at the computers. In addition to the individualized stations, Abigail utilized the online companion software for her math textbook for direct instruction and guided practice. In one observation, the students sat with Abigail on the carpet with math worksheets while one student manipulated a

computer program in the back of the class (Field notes: Dec. 13, 2011). This program was projected for the students at the carpet. The teacher directed the student at the computer to start and pause the online activities so that she could offer further explanation and engage the students with questions. The students at the carpet followed along with the computer program on their worksheets. The students seemed very engaged with this program.

Both the interviews and observations of Abigail showed evidence of technological pedagogical content knowledge, but she was not using "transformative technologies" (Eteokleous, 2008). When she discussed her role as a teacher, she talked about direct instruction and the use of a didactic approach before discussing the need for students to engage with the information themselves.

> So my role as a teacher is first to be the one that teaches things and then the second is to guide children to discovery for themselves. Because even though you teach it, they don't really get that "Aha!" moment until they do it themselves. They have to experience it with manipulatives or little games like this and things like that and I don't think it goes into your head though until you get to do it yourself. (Post interview)

In her classroom, she viewed the computers as a source of guided and independent practice for her students. While she chose technology that was closely aligned with her students' objectives, tracked individual student progress, and differentiated instruction accordingly, the technologies that her students used did not allow the students to take control and guide their own learning or construct new ways of

thinking about the subject matter. The students were consumers of the information from the technology rather than creators or co-creators of the information. The age level of her students may have influenced her technology choices. She repeatedly emphasized that lower grade levels were the last to get new technology. Additionally, her students were just learning to write and may not have had the skills to "create" information on their own yet. In observations of writing, Abigail had to model and explain the writing of each letter when starting a journal prompt with her students (Field notes: August 23, 2011).

Christopher. Christopher was the only bilingual teacher in the Traditional Early Elementary team. He was also the only male teacher in this team. His current class was a self-contained 2nd/3rd split class, but he had previous teaching experience with ages ranging from kindergarten through college, in the U.S. and abroad. He had over thirty years of total teaching experience and stated that he was close to retirement (Pre-interview). He had taught the last fifteen years at Openwood Elementary.

During the interviews and throughout the process, Christopher seemed eager to please me and give the “right answers”. At the end of the first interview he even said that I should delete any of his answers that were not in line with my study. He did this despite my reassurance that I wanted candid and truthful responses, and that there was no “right” answer.

Christopher felt that as a teacher, it was his responsibility not only to teach his students the core subjects, but also to teach them good citizenship and respect for others. Both in pre-interviews and post-interviews, he talked about the importance of modeling this respectful behavior for his students. Christopher described himself saying, “I'm

considered a very friendly, competent teacher and I'm the kind of teacher that the students can always come to when they have a problem" (Pre-interview). He also placed a lot of emphasis on continuously monitoring his students' progress and re-teaching when necessary. This was something that he expressed in the pre-interview, even before the principal started to stress assessment and tracking student progress.

> That means I constantly assess my students in order to see if they are with me, following me. But, if I see that they are not comprehending - don't have enough comprehension on something about the lesson, I want to stop in order to clarify or repeat in order to make sure they are in the right way. (Pre-Interview)

Like many of the other teachers, Christopher described his typical lesson using a lesson cycle: reviewing and connecting to previous material, direct introduction of new material, guided practice, followed by independent practice. He asked questions during both the guided and independent practice to check students' understanding. During independent practice, he described being able to pull small groups that need extra time and instruction to master the lesson content. In observations, Christopher seemed to closely follow this lesson cycle (Field notes: August 23, August 30, December 2, 2011). Christopher also placed a large emphasis on vocabulary and started all reading lessons by introducing or reviewing vocabulary words with his students. This emphasis was evident both in his interviews and later in the class observations (Field notes: August 30, December 2, 2011).

Christopher continually responded that it was important for students to use technology, and that he tried to incorporate it frequently in his instruction. In the first interview, I was suspicious that he was trying to give the "right" answer, but later I observed him using technology with his students in multiple observations (Field notes: August 23, August 30, December 2). He was aware that his students encountered technology daily and seemed to have a broader definition of technology than the other teachers.

> Well, this is very important. This technology is one of the important areas, important resources that a student and a teacher have to have in the classroom because you go anywhere out of the school, even the smallest store or the smallest business is managing everything based on the computer system. That's why not only technology, but you can see cell phones, you can see different iPads, different - a lot of - everything is technology now. Even if you go to any house, you see microwaves, you can see stoves, you can see everything down to the washing machine, the dryer, everything is technology. Then that's why students have to be very, very, very familiar with the technology and not just touch technology but learning how that technology or computers are functioning. This is very, very, very important and for teachers also. The teachers have to be also updated and teachers have to be or get prepared for the new challenges in education. (Post interview)

He felt that both Openwood, as a school, and he, as a teacher, needed to make improvements towards more technology integration in the classroom. He admitted that while he was learning and tried to bring technology into his class, he was still not as comfortable with technology as he would like to be. He felt that having more computers would allow him to use technology more frequently.

> Well, in [Openwood], we have to improve a lot. We are using - I want to say just at the classroom level, but simply, we're very poor and because this year or last year, we had teachers worked - they didn't have computers in the classroom. Or if they had, they use only one or two, but they are not enough. Definitely, Openwood is working on their level. According to my opinion, I would like to see probably ten or more computers in each class. Hopefully, we could have at least ten computers, but you can see we have only three. In order for my students use those computers, we have to make a schedule like, working like probably half of the students today and the other half tomorrow. Obviously, it's not enough, but I would like to have at least one for every two students. (Pre-interview)

Christopher felt that the lack of technology was detrimental to his students and that it put them behind students at other schools where technology was more prominent.

> Compared with those schools, obviously, our students are affected because they don't have the opportunity to have access to the new technology. I can see when they go to other schools or I see these schools - we're going to the middle schools, I can see the differences when all the students - the

> other students coming from schools with technology and my students, our students without technology, we can see the difference and they are the computer labs. Our students definitely are affected. (Pre- Interview)

In his class, Christopher used his computers in three main ways: a) direct instruction/ presentation tool, b) skill practice, c) independent research. The computer and projector were used during reading lessons to display the text for the whole class. In addition, the reading textbook had a companion site that offered video clips and quizzes. Christopher would have one student sit at the computer and manipulate the mouse while he gave his whole class reading lesson (Field notes: August 23,August 30, 2011). For skill practice, students used drill and practice Math software programs and electronic reading quizzes to apply their new knowledge and demonstrate mastery of particular skills. Finally, the teacher allowed the students to search science topics online using educational websites (Field notes: December 2, 2011). For these projects, students used educational search engines that would tailor the results rather than searching unmonitored on Google or another large search engine. Students used the information that they learned to write science reports. Only the last use of technology can be considered "transformative" (Eteokleous, 2008), and this method of using technology was infrequent.

Although Christopher was close to retirement and did not want to change to a completely new Montessori teaching style, he had a very positive attitude towards professional development and continued evolution of this teaching practice. He participated in several trainings over the summer and throughout the first semester of

school. He said that he did not like to think of professional development as "required" but rather went because "he wanted to" even if the school was requiring him to attend the trainings (Post interview). When asked if he felt that the professional development experiences were beneficial he responded, "I'm using new strategies, not new knowledge, but new strategies, new ways to teach. That means like I told you at the beginning, the trainings I'm taking allow me to be better teacher. It doesn't mean that I'm learning a lot but I'm - yes, I'm getting a lot of new strategies for my classroom, for my students" (Post interview).

Emily. Emily was in her fifth year of teaching at Openwood elementary and had seven total years of teaching experience. She did not consent to a pre-interview, but was very active in the Lesson Study Professional Development and agreed to a post-interview.

She saw herself as a facilitator of learning and tried to "give [her students] the tools that they need[ed] to use what I'm teaching in life, and be able to take that and just kind of do what they will with it, what they can" (Post interview). Although she did use some direct instruction in her teaching, it was evident in her interview and in multiple class observations that her students spend much of their time working independently or in small groups (Field notes: August 29, September 9, September 16, and December 3, 2011). Emily used rotating stations daily so that her students were given a variety of practice with each skill that they need to learn. She had four computers in her room that also served as a station during this independent practice time.

Emily felt that technology "should assist what the students have already learned just to build upon" (Post Interview). In addition to this comment, she felt that technology was necessary for her students to learn.

> Well, unfortunately, I say unfortunately but I guess fortunately, it just seems that's the way that it's going. You know, everything is technology-based and so it's hard to say that it shouldn't be incorporated. I use it all the time so it's hard for me to say just things that I know that's when my kids are my age, it's just going to be much more advanced. They'll need to know. They'll need to be able to use it, understand it and have that basis just like reading - you can't just open a program and be able to understand it. (Post interview)

Emily reported that she was "pretty comfortable. I wouldn't say I'm very comfortable but I use [technology]" (Post interview). In addition to the computers being a station, Emily used the projector to facilitate whole class instruction with her students (Field notes: September 16, 2011). During the stations, students used educational software or educational websites to practice math and reading skills. Emily used these tools as an intervention, "mainly because the computer programs tend to be a little bit more interactive and keep your attention. And so, they've just always been presented to the schools as, 'This is another type of intervention'" (Post interview).

In addition to in-class technology, Emily encouraged her students to use technology for their monthly homework projects. For these projects, Emily's students researched and presented on an assigned topic each month. The students could choose to

use technology in their presentation. Technology use for these projects was based largely on their parents and their home environment because all of the work on the project was completed at home. While this could be a transformative use of technology, the at-home assignment left the burden of modeling and monitoring technology use to the parents.

Emily felt that Openwood was behind in its technology integration, especially given its importance in the students' lives. She noted that her previous school had a computer lab several years ago, but that this was the first year Openwood had a computer lab for the students to attend on a regular basis. She also stated that this regular attendance in the computer lab class had helped her children to use the computer more independently in her own classroom.

Another factor driving Emily's instructional decisions was the fact that she was being shadowed by a student teacher during the semester of the study. During meetings and in casual conversations, she commented that having Frances, the student teacher, in her class had made her more aware of planning and managing her time in the classroom. She wanted to set a good example for Frances, so she worked very hard to stick to the schedule that she had set for her class. In previous years, she reported spending more time on reading and math, but frequently skipping science and social studies lessons. This year, with better time management, she was able to cover all of the subjects, and enjoyed bringing more hands-on science lessons into the classroom. She stated that she enjoyed "seeing [the students] and how much better they perform when they are doing something that's fun and hands-on, and how much better they learn" (Post interview).

She also reported that she preferred hands-on learning activities in professional development.

In her team, Emily took a pseudo-leadership role. From the beginning of the school year, Emily took an indirect leadership position on the team. In contrast to Deborah's more overt leadership, Emily guided the team meetings and the lesson study professional development more subtly by managing the team binder, recording minutes, and meeting agendas. Emily was very organized and always kept track of the latest school updates. Because of this, the team relied on her to make sure that they were meeting deadlines throughout the semester. During team meetings, her body language frequently indicated annoyance with Deborah's comments, but Emily was very professional in her interactions and did not directly confront Deborah. Also, she usually waited to add her input or thoughts to the meeting until she was asked.

In regards to the lesson study professional development, Emily volunteered to conduct the model lesson and took most of the responsibility for choosing, modeling, and scheduling the research lesson. She said that using a science lesson for the model lesson helped her to accomplish her goal of focusing more on science. Other than the push for more science, Emily did not report any changes in her teaching or in her technology due to the lesson study professional development. When asked if she would participate in lesson study professional development again, she responded, "Everything we did, we do that anyways. So, it wasn't like it was excellent for me, so I wouldn't be opposed to it, per se" (Post interview).

In terms of general professional development, Emily stated:

> I like the hands-on professional developments that are really sufficient to the classroom. I can take it back and I can use it in the classroom. For instance the High Frequency Word. It was just tons of things that we could use in the classroom with High Frequency Words. That's what we need. The cons I think are just the - I feel like sometimes we get to personal developments and you're hearing the same thing you've heard in the past or it's just packets of - for you to read about this or that or whatever it is they're presenting and it doesn't necessarily benefit me here in the classroom and make me a better teacher. (Post Interview)

When comparing lesson study professional development to other professional development activities, she said that they "[didn't] even really compare. I mean, it seems like two totally different things to me" (Post interview). On the other hand, she did like the process of the lesson study professional development, and felt that it should be considered professional development.

> I like the fact that with that, you are working with a team and you're reflecting and you're looking at your teaching and you're able to watch someone else because you could learn a lot from that. So, that aspect of it, I think, is definitely to be considered as a professional development. (Post interview)

Frances. Frances was the student teacher shadowing Emily during the semester of the research project. She was in the final semester of her degree and left the school

before I was able to get a post interview with her. All data in this profile is from her pre-interview, observations of Emily's class, and team meetings. She had not done any actually teaching prior to her interview but did begin to teach some lessons as the semester progressed. She did not consent to me observing these lessons.

Frances believed that her role as a teacher should be as a "facilitator" and she stressed the importance of open communication with both her future students and with their parents. For her students, she wanted to be "a person that they can feel comfortable in coming to with either anything academic or life skills or anything personal" (Pre-interview). She also wanted to teach in the lower grades level because of the high stakes testing that started in third grade. However, her ultimate career goal was not to teach in public schools, but rather to teach for a short a few years before opening an afterschool program for kids. She saw teaching a stepping stone rather than her long-term career.

Still being in school, Frances had recently taken two required technology courses in her teacher education program at the university. Even with these courses in technology, she was not confident in her abilities to integrate technology into her teaching.

> I'm so-so because as I said I'm kind of old school. I don't, I'm not, I don't like technology that much, but I have to learn how to use it because I use it every day socially and everything. I use it every day but as far as using it to teach is something that I have to really learn how to do with experience. (Pre-interview)

She did state that by observing Emily she was able to see which types of technology the students were familiar with and their ease in using those programs. She planned to continue to use the computer software when she taught in Emily's class.

Being so new, Frances did not feel comfortable having me observe her teaching. Based on casual conversations with both Emily and Frances, her first few days teaching the class were difficult. The students tested her authority and misbehaved. After a few days, she was able to command more authority and, in turn, the students' behavior improved.

She was excited when we first met to discuss lesson study professional development. She was eager to participate and said that the process was similar to activities she had done in her university education courses. However, in the team meetings she was mainly an observer and rarely spoke. She continued this observer role when the team discussed the lesson study professional development, even though I encouraged her to participate more actively.

The next sections uses researcher observations, group meeting transcripts, and teacher post interviews to understand the lesson study process within Team 1.

Lesson Study Professional Development

As previously mentioned, this team of teachers was chosen by the principal as one of the first teams to begin the Lesson Study Professional development. She felt that they would be more open and willing to integrate technology than the other teacher teams. This team started as two different teacher teams with Deborah, Bridgette, and a third teacher as the 2nd/3rd grade team and Abigail, Christopher, and Emily as a 1st/2nd/3rd team.

The team was split in order to have smaller, more manageable teacher groups. However, when the third 2nd/3rd class was cut, the remaining teachers where given the option to meet together as one team. In the first meeting, the teachers met together and decided to complete the lesson study professional development together. The team felt that being involved in the research study was not much more work than the lesson study professional development itself, and all team members consented to the research study.

In conjunction with a new writing curriculum and a new science curriculum, the principal suggested the group choose a writing or science lesson for their lesson study professional development. This team decided to focus on science for the technology-infused lesson study professional development.

Rather than having a set time to conduct the lesson study professional development, the teachers were told to complete the cycle during their weekly team meetings. In previous years, these weekly team meetings had taken place in the principal's office and were led by the principal. The year of the study, the principal wanted to give the teachers more autonomy and charged them with managing their own weekly team meetings in their classrooms. Deborah was the team leader, and the weekly team meetings usually took place in her classroom.

During the weekly meetings, the teams were to discuss student progress, the lesson study professional development, and any other miscellaneous issues that the team needed to coordinate. These issues included grading, scheduling field trips and other school functions, and benchmark testing. The meetings were forty-five minutes long and took place during the teachers' daily planning time. In this state, teachers were required

to have “450 minutes of planning time every two weeks in increments of not less than 45 minutes within the instructional day” (Texas Education code, Sec 21.404). These teachers received 50 minutes daily, for a total of 500 minutes every two weeks. The principal stated that she gave them longer daily planning periods so that she could require them to participate in the weekly team meetings. However, requiring the teachers to participate weekly meant that they were only receiving 400 minutes of unscheduled planning time every two weeks.

I attended all of this team’s group meetings from August 30, 2011 through December 13, 2011. Figure 3 shows a synopsis of the meetings where the technology-infused lesson study professional development was discussed. The following section gives a more in-depth description of this team’s weekly meetings.

As team leader, Deborah’s goal was to conduct the meetings as quickly as possible. She made this evident in the first few meetings by setting a timer for fifteen minutes, even though the meetings were scheduled to last for the entire fifty minute planning period. In this meeting, and in subsequent meetings, the team went well over the fifteen minutes. They used the entire planning period and often ran out of time before finishing their discussions. In the first two meetings, Deborah reset the timer every fifteen minutes. After the third team meeting Deborah stopped setting a timer (Team 1: August 30, September 6, September 13, & September 20, 2011).

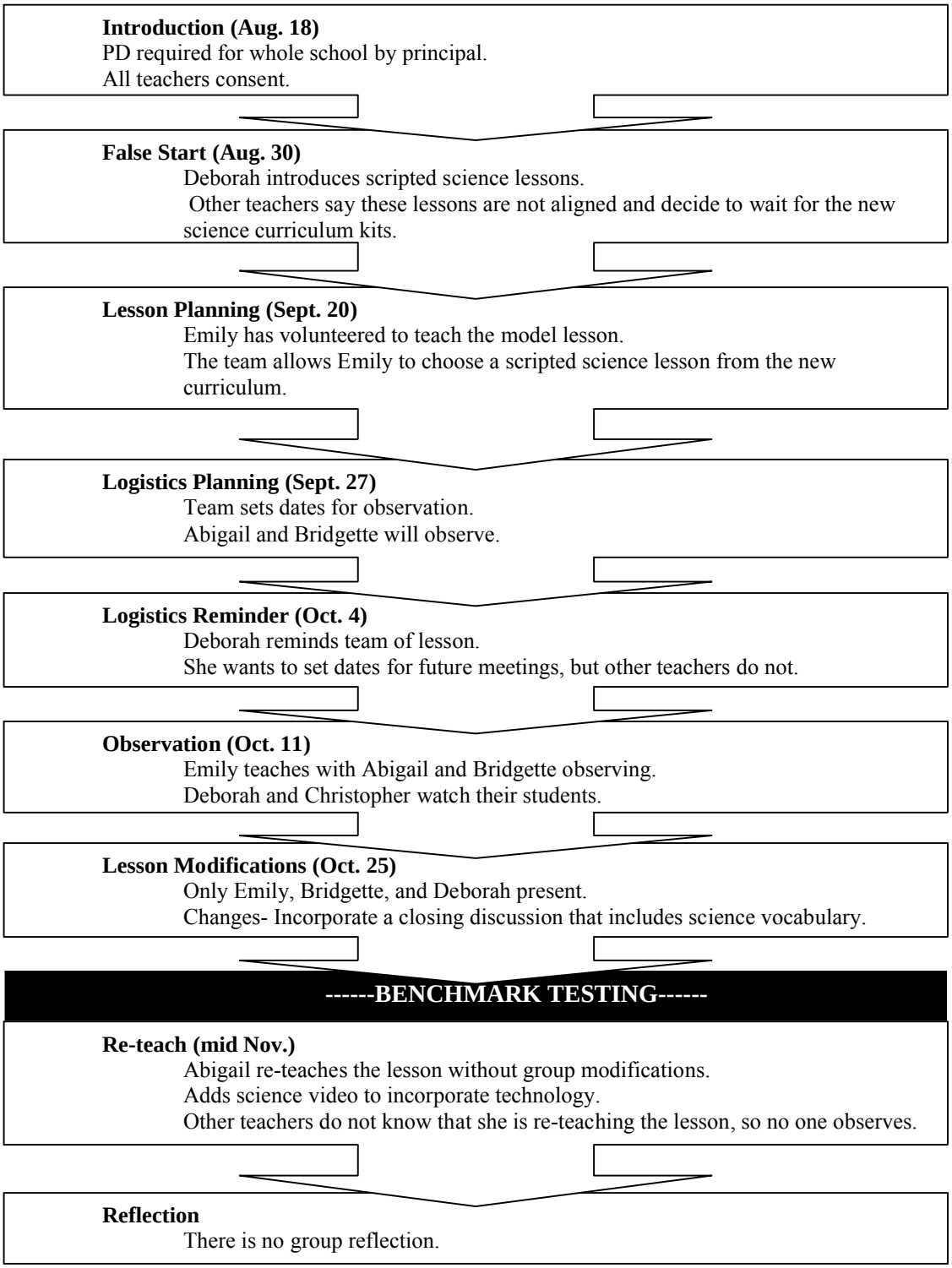


Figure 3: Team 1: Lesson study professional development (August 18 - December 13, 2011)

As mentioned earlier Deborah was concerned with helping me finish my dissertation research. Deborah always referred to the process as "Sara's project" and continually asked me what the group needed to do in order for me to complete my study. My response was always to review the lesson study protocol and then turn it back to the group for discussion. To facilitate the process of lesson study professional development, Deborah brought it up immediately in the first meeting of the semester. In the first meeting Deborah presented the teachers with scripted science lessons that she thought would be appropriate for the research lesson. The other teachers argued that her lessons are not aligned to the new science curriculum. Abigail starts to question the alignment of the lesson:

> Deborah: I have a suggestion for the science lesson. This one, page 42, or this one, page 16, or I'm open to suggestions. It's just, those are my two thoughts. (She passes a science lesson book around the table.)
>
> Abigail: Does this go along with our [curriculum]?
>
> Deborah: Yeah, I mean we're doing, uh...
>
> Abigail: We're doing properties of matter in first grade right now and then we're going to do liquids and solids. Just fyi…
>
> Deborah: We'll I have some on liquids and solids too if you want that.
>
> Abigail: I'm just saying that I think it needs to be with our… Does it matter? I think it needs to be aligned. (Team 1: August 30, 2012)

The teachers finally decide that they can use a scripted lesson called "Sink or Float" that concentrates on the properties of matter, but Emily and Abigail are still not completely on board with this lesson. They were still questioning the alignment of the lessons to their grade level.

Deborah: So do you want to do the one on "Sink or float"? That's properties of matter. I don't have it right here, but I can pull it. I have a sheet on that. I mean I have one of these one that. Because that's one of our objectives too for matter. Is everybody okay with that or do ya'll want to pick your own? Or how do you want to deal with that?

Emily: I'm fine with that.

Deborah: Anybody else? [Christopher] is "Sink or float" okay with you?

Christopher: Yes.

Deborah: It's in here. Measure, test, and record physical properties of matter including temperature, mass, magnetism, and ability to sink or float.

Emily: I don't think that's…

Deborah: Second?

Emily: Is says second there? Okay.

Deborah: But it is, whether it's specifically stated or not, it's a property of matter, so…

Emily: It's a property.

Deborah: So, You have a different thought or?

Abigail: I can understand that the properties are wood, plastic, metal, shape, size, color. That's probably too much (Team 1: August 30, 2011).

The group's conversation was derailed when a district professional development specialist, Ureilly, dropped into the meeting unannounced. Ureilly wanted to introduce herself and offer her assistance to the team. She heard the team discussing the science lesson and offered several resources including Power Points for all of the science objectives and online science software. Ureilly went on to describe materials she could provide for other subjects. The teachers expressed interest in some of the materials that she offered, but they all seemed eager for her to stop talking. Ureilly took up the rest of their meeting time, and the team did not fully resolve the issue of which lesson to use for the lesson study professional development.

The campus reading specialist joined the team at their next meeting on September 6, 2011. In this meeting, the team discussed the process and scheduling of a beginning of year reading test. Each child had to be tested individually. The reading specialist would be rotating to help the teachers accomplish this task. There was no discussion of lesson study professional development in this meeting.

The reading specialist attended the meeting again the following week on September 13, 2011. This week the discussion covered several different topics such as scheduling a field trip, turning in weekly lesson plans, and the new district appraisal system for teachers. The group did not discuss the lesson study, but Deborah made a

point to tell me that they had not chosen a research lesson and that she would "take the lead on that in the next week" (Team 1: September 13, 2011).

Sometime after this meeting, these teachers had informal conversations about the lesson study professional development. They decided that Emily, not Deborah, would teach the research lesson. At this point, Emily took the lead on the lesson study professional development. She chose a scripted lesson from new science curriculum. She had recently attended professional development training where the science lessons were modeled. Emily presented this lesson to Bridgette and Abigail on September 20, 2012. Since she had practiced the lesson at her professional development, Emily was able to offer suggestions for improving the scripted lesson plan before they even taught the initial research lesson:

> Emily: So, you have a plastic pan and you put a drop of glue and a drop of water. And then you turn it up and you watch to see which one races down the fastest. And then you do it with the oil and the glue and, the oil and the water. However, the only downfall with that is, Can you imagine them trying to make a drop. That would be a disaster.
>
> Bridgette: You could use an eyedropper.
>
> Emily: Well, we didn't. They provide little spoons. So I could see someone just getting the biggest glob of glue. So that would be probably a problem. But, it could be something that we do and it could be revised afterwards because aren't we doing a second one?

> So that could always be a revision. (Laughing) I could just make mine a disaster the first time. No, I'm kidding. But that actually stood out to me when we were all doing it.

Christopher and Deborah were both absent from this team meeting due to a field trip. Bridgette and Abigail agreed to the scripted "Liquid Races" lesson. This lesson did not include technology, but the team had previously discussed using a scripted science lesson from the new curriculum and adding technology into the revised lesson.

The following week, September 27, 2011, Emily told Christopher and Deborah about their chosen lesson. Then the team set a date for the research lesson. Emily guided the scheduling process since she would be teaching the first lesson. Because the lesson was part of a sequenced unit on matter, Emily had to wait to teach the lesson for almost a month. This waiting period significantly delayed the team's lesson study progress. The principal had offered to cover the classes so that all teachers would be able to observe at the same time. However, Deborah pointed out that this would probably mean another teacher on the campus would lose their teacher aide. Rather than affect other teachers on campus, the teachers on this team decided to rotate the observations. For this first lesson Abigail and Bridgette would observe Emily's lesson. Deborah and Christopher would not observe this lesson. Instead, they planned to supervise Abigail and Bridgette's classes. For the re-teach lesson, Abigail would teach the revised lesson while Deborah and Christopher observed her.

The team went two weeks without discussing the lesson-study professional development. During these meetings the teachers spoke about professional development

workshops that they had attended and still needed to attend, report cards and grading, the logistics of an upcoming school program, and various student issues.

Several weeks later, on October 4, 2011, Deborah reminded the group of the upcoming lesson observation. Abigail and Bridgette observed Emily's lesson. The lesson was a science experiment in which the students tested different liquids to see which one would flow faster down a horizontal surface. Emily already had everything set up for the students at the start of the lesson. Frances, her student teacher, helped Emily pass out the materials. At the beginning of the lesson, Emily gave a clear explanation of the experiment and her expectations for the students' behavior. For the experiment, the students placed drops of glue, shampoo, and oil on a plate. Then, they turned the plate sideways to see which liquid trickled to the bottom of the plate the fastest. Although this had the potential to be very messy, there were no major spills during the lesson. Emily finished the lesson by graphing the students' results on the board. During the observation, Abigail and Bridgette spoke to each other about different students in the class. They had each taught some of these students before and were impressed by their progress. They also praised Emily's teaching skills, focusing mainly on how prepared she was for the lesson and how smoothly the lesson ran.

Before the next team meeting on October 25, 2011, Abigail was moved to another teacher group due to scheduling changes in her planning period. She and this original group chose for her to continue on in the lesson study professional development with them despite schedule availability issues. With this issue resolved, Emily, Deborah, and Bridgette met briefly to add modifications to the lesson. Christopher was absent from the

meeting for another professional development training. When discussing the lesson revisions, Deborah first asked for my suggestions. Rather than answering, I redirected the conversation and asked Emily for her suggestions as the model teacher. Emily felt that the lesson needed more of a conclusion that would tie the experiment to the science vocabulary.

Bridgette: According to you, do you see any revisions that we can make, or any suggestions that we can give, so that we.

Researcher: So, I actually don't want to be in the revision process. I would like it to be you guys, but you can decide how much or how little you want to revise. So if you guys feel like it went well, I heard [Abigail] give you suggestions the other day and she said the things that she really like when we were in the classroom, so I would definitely keep those. Do you feel like, were there parts that you felt like didn't go as well as you had hopes or expected?

Deborah: Well, what did suggestions did [Abigail] say, maybe we can use those?

Bridgette: She commented on the good stuff that [Emily] used that she had never thought of, like the preparation, you know.

Deborah: So did she make any suggestions? You said she made suggestions.

Researcher: No

Deborah: Suggestions for what she would do based on what she saw

Researcher: Yes, but they were things that she would do that she saw [Emily] do, but they were not new things.

Deborah: So that would not work for revisions. Can you think of anything, since you taught it, that they could do easily?

Emily: The only thing I can think of is the terms, velocity, and what's the other one…There's one other word that kind of describes what that whole activity was about and it doesn't really have us introduce those words during that lesson. And I don't remember when we did it in the summer [training] if it even follows up uses those words, but to me that might be something that could be incorporated at the end of the lesson. Because I felt like the lessons just kind of have them go back to their journals and then it doesn't really take it anywhere else. And then…

Bridgette: Right, the conclusions in there will be set up. Water is the fastest. That part should be revised.

They continued to discuss using more science vocabulary in the conclusion. This was the only revision that was made to the science lesson. The group did not discuss adding any technology to the lesson even though they were supposed to be completing a technology-infused lesson. Emily planned to convey the revisions to Abigail before the re-teach of the lesson. As previously stated, Christopher and Deborah were supposed to observe Abigail teaching the lesson. No observation date was set for the re-teach lesson since Abigail and Christopher were not in attendance at this meeting.

Because they did not share a planning period during this part of the semester, Emily and Abigail were not able to speak on a regular basis. Emily was never able to relay the team's lesson changes to Abigail. Abigail finally re-taught the lesson to her class without the team's modifications. Abigail did add a technology component to her lesson by showing an online science video to reinforce the lesson. She did not notify me or the other teachers that she was re-teaching the lesson, so Christopher and Deborah did not observe the lesson.

The lesson re-teach by Abigail took place in the same week as the district benchmark testing. The students did not perform well on these standardized tests, and the principal became very concerned about the students' performance on the upcoming standardized tests. After the benchmark tests, the teacher team meetings were moved to the principal's office and the lesson study professional development was not discussed at all. The principal led these meetings and focused on creating common assessments, tracking student progress, and strategies for improving student test scores. The group did not complete the final reflection.

Research Questions

1. *How do teachers in a technology-infused lesson study group develop (a) their attitudes toward technology and (b) their technological pedagogical content knowledge (TPACK)?*

Prior to the start of the lesson study professional development this group reported generally positive attitudes toward technology, but varying degrees of actual technology use in the classroom. Table 7 shows selected pre- and post interview quotes about technology from the teachers. Christopher and Bridgette offered the most positive

attitudes, while Abigail and Emily both talked about the importance of balancing technology with other teaching methods. Deborah and Abigail commented on the lack of technology resources, and how that plays a role in their ability to integrate technology in the classroom.

Table 7

Team 1: Technology beliefs pre- and post lesson study professional development.

	Comments About the Role of Technology in Schools	
Teacher	**Pre-Interview**	**Post interview**
Deborah	I think if we had good computers, I think it could many things. I think it could be diagnostic. I think it could be reinforcement. And on certain skills I think it could even teach lower students that you don't have time to teach. But, I think when you get these old, outdated, donated machines, um, it's very limited. I think what you're going to get there is, you're going to get practice basically. But it also requires that the teacher take a lot of time organizing that, because you only have 2 or 4 computers and you have 20 kids.	I don't think that when you're given four old outdated computers, they computers play much of a role. I think that we're at a point where every student should have a computer and we don't have that. So, what they could do if they had computers and if they had decent computers is very different than what we have. So, I mean, I do intend to use computers. I think probably I should be hooking my computers up to the, I guess what you might call the presentation device we have here. So that might just be something that I haven't had time to do that will prove to be able to bring maybe more into my classroom. You know what I'm saying, like more quickly I can pull up for example , just examples of matter or something that is a little more interesting than put something up of the board. And so that's just a limitation of not having enough time to move forward.

Bridgette	I do use a lot of technology. So when I was in school we learned how to teach the students to create these projects where they take pictures of the objects that have the same color and they put all of those pictures together. Two years ago, I did a PowerPoint presentation with my second-grade students and my first-grade students and we were going on a field trip to the aquarium so we learned about sea animals and things like that. So we took pictures, we searched for those pictures and we put them together and we presented their presentations. So that's what we did, yeah.	It should play a big role and then - yes. We do story online. So you do - have read allowance in your room but it makes it easier for the ELLs to see the illustrations and the pictures and things like that. It makes it easier for them to understand. We do have United Streaming. Brain Pop Junior has a lot of different suggestions for you to choose from. Most of the games are interactive. We do those together. I see what needs to be re-taught and things like that so you can go back and re-teach. Usually, I search for stories or whatever that need to go with the objectives the night before and then have that ready and I have a computer expert, a student, and that student will go back there and do the clicking and moving this
Abigail	I think it has to be an anchor in your classroom. There has to be a balance. I think there should, but I don't think kids should be on a computer all day without any direct instruction from a teacher. Because not everybody learns that way. I think you have to hit, I mean maybe there's some kids that don't learn from direct instruction. They just don't get it, but you put them at the computer with a program that's really a good program and they will get it. And that's why I'm so sold on Waterford, because if they're not getting it from me, at least they're getting it from Waterford, you know? At least they're getting it that way, and children are so media savvy today. I mean, they all have an X box or a whatever the newest one is. (Laughter) Many of them have their own telephones, which I find in kindergarten and first grade just amazing that they might have their own cell phones.	Well, I think it's really important because these children are the ones that are - these children and their parents, but many of my parents aren't economically well-off enough to be able to get a home computer. These children are the ones who are going to be using computers and whatever comes next so I think they need to use that. Having said that, because I'm in a primary grade and I have always been in the primary grade, we are not considered really important when it comes to handing out the computers. So consequently, my computers are always very old and when they buy new ones, they place them in the upper grades first, which I do understand but these guys are important, too. Well, I've always used technology. Even in the days of film strips and films, I was the teacher on campus who ordered the films from the Film Library and the other teachers always wanted to join my class to see the film but they didn't want to order the film.

Christopher	Technology is very important especially at this time. At this time, the students are coming with cell phones in school, they're making calculators, they can use a computer, they can…most of them have computers and we have to recognize that technology - any kind of technology, especially the one that is for teaching or learning, is really important. Students have to be involved with technology matter, definitely. Well, I think that we have to recognize. We have some computers. We, as teachers, we want to have more support in technology, but we have to recognize that we have to work on that area, definitely. We, as teachers, all the administrators have to be involved in this situation and try to get some more technology for more college students or teachers. It's definitely, yes, we have to improve at that area.	Well, this is very important. This technology is one of the important areas, important resource that a student and a teacher have to have in the classroom because you got anywhere and out of the school even the smallest store or the smallest business is managing everything or [unintelligible] everything based on the computer system. That's why not only technology but you can see cell phones, you can see different iPads, different - a lot of - everything is technology now. Even you got to any house, you see microwaves, you can see stoves, you can see everything down to the washing machine, the dryer, everything is technology. Then that's why students have to be very, very, very familiar with the technology and not just touch technology but learning how that technology or computers are functioning. This is very, very, very important and for teachers also. The teachers have to be also updated and teachers have to be or get prepared for the new challenges in education. In my classroom, I use computers and I use a lot of software computers for different programs, for reading and math. Also but now, this year I'm using a lot of resources software for science. This is great because you can see here my students are writing. Right here.
Emily	No pre-interview	I think it should assist what the students have already learned just to build upon. Well, unfortunately, I say unfortunately but I guess fortunately, it just seems that's the way that it's going. You know, everything is technology-based and so it's hard to say that it shouldn't be incorporated. I use it all the time so it's hard for me to say just things that I know that's when my kids are my age, it's just going to be much more advanced. They'll need to know. They'll need to be able to use it, understand it and have that basis just like reading - you can't just open a program and be able to understand it.

Classroom technology use was observed during the 4-5 classroom visits per teacher throughout the semester. Abigail's and Emily's students used computers daily. Both teachers utilized math and reading software programs that were bought by the school to supplement the students' whole group instruction and independent practice. Christopher and Bridgette also reported that students used these software programs, but not on a daily basis. In observations, the students in their classes were not seen working with the computers. In interviews, both Bridgette and Deborah stated that they used or intended for their students to use technology in the classroom, but no technology use was observed. Bridgette said that her students used the computer software as a station and that they used the projection software to read books to one another. Additionally, she discussed a power point project that she had done in a previous year. She had not yet done this activity with her current class. Deborah also wanted her students to use the software, but was not familiar with many of the programs purchased for use. This was evident in one of the team meetings when she asked the other teachers to about the quality of the textbook companion software (Team 1, September 27, 2011). At the beginning of the year, Deborah worked diligently to get additional computers in her classroom. However, she complained that there was limited Internet access that prevented her students from using the computers.

Very little change was seen in the students' technology use over the course of the semester. Near the end of the semester, Christopher had his students research science topics online using restricted or educational databases. The students summarized the information that they found in short essays with illustrations. The final student papers

were displayed in Christopher's classroom. In December, Deborah purchased an assessment software in December for her students to use. She had used the program previously and felt it would help her become more efficient in assessing her students' knowledge and grading them quickly (Post interview). Since the software was purchased late in the semester, she did not have an opportunity for the students to use the software during the time of this study.

Teacher use of technology also differed across the classes. Abigail and Christopher used the computer and projector to conduct whole class lessons. They projected stories and lessons from the textbook companion website, having a designated student control the computer while they directed the class. Although Emily stated that she sometimes used the computer and projector to show videos and images to her students, none of the other teachers were observed using technology for instructional purposes. All of the teachers in this group used their computers for administrative tasks such as: grading, attendance, typing lesson plans, and communicating with school personnel through email. Like student use of technology, there was little change in the teachers' use of technology in the classroom.

All of the teachers except Bridgette expressed some technological, pedagogical, and content based reasoning for why they used or did not use technology in their classroom. Abigail, Emily, and Christopher felt that the programs they used, Waterford reading software, Reading Street software, and a math software program, were effective because these programs emphasized the district standards (such as mastering multiplication facts and counting money), tracked individual student progress, and

included targeted re-teaching sections on each objective for struggling students. In one meeting, Deborah asked about the rigor of the math software program (Team 1: September 27, 2011). She wanted to ensure the math content her students were practicing in this software was at a higher-order level. Bridgette, who had the least amount of observed technology use, was able to offer examples of technology use in previous classes and stated that she used the same software programs as the other teachers. As previously mentioned, Bridgette described a project where students used PowerPoint and photos to create a report. This was one of the most constructivist examples of technology use generated from the group members. However, Bridgette did not convey a deep TPACK understanding about the project. She demonstrated technology knowledge, "They have to know how to use like the mouse, the keypad, and they know how to type and things like that" and pedagogical knowledge, "I have a lot of like collaborative learning groups. So they go to the groups and they work together. So a lot of movement but at the same time there's a purpose of that" (Pre-interview), but did not ever express a sense of integration between the technological, pedagogical, and content knowledge. Without TPACK, she used technology infrequently and had not completed the constructivist technology project with her students in two years.

Because this group chose a "divide and conquer" strategy for completing the lesson study professional development, they spent very little time discussing technology integration into the lesson. At the beginning of the semester, the team discussed adding technology to the revised lesson (Team 1: August 18, 2011). In the first lesson study meeting, Deborah proposed two scripted lessons that did not include technology. The

team rejected those lessons, and tentatively chose another scripted science lesson called "Sink or Float". This lesson did not include technology either, but the district professional development specialist, Ureilly, offered the team a complementary PowerPoint that they could share with their children. She also discussed an online science program called "Gizmos". With this website the children could do simulated science experiences on the computer. Ureilly stated that she would check if the teachers had licenses to use this website. I do not know if Ureilly ever provided these materials to the teachers, but I never observed any of the teachers using them. Later, the team chose to do the "Liquid Races" scripted lesson instead of the "Sink or Float" lesson. This lesson did not include technology (Team 1: September 20, 2011). Technology was not discussed in the meeting where Emily, Deborah, and Bridgette revised the research lesson (Team 1: October 25, 2011). In the final re-teach, Abigail added a science video to incorporate technology, but she did not share this with her team.

The team did have some discussion of technology in weekly meetings that was not related to the technology-infused lesson study. On September 6, 2011, the teachers and the school reading specialist discussed the use of a palm pilot to individually test student's reading level. These devices were supposed to be loaded with their student information so that they could track each child's score. These scores directly uploaded to the district using the palm pilots. The teachers had used the palm pilots in the past, but some of their devices were not working properly. The conversations in this meeting focused on technology knowledge and troubleshooting technology issues. On September 27, 2011, the team had a conversation where Emily, Abigail, and Christopher encouraged

Deborah to explore the new math software. This was the only meeting all semester that technology was discussed as an instructional tool. Deborah was concerned about the level of problems that her students would answer using the program. Abigail, Christopher, and Emily explained that most of the problems were not at higher-order thinking skills, but that it was still good practice for the students. Emily suggested that she attend a professional development training of the software to become more familiar with it. The last instance of technology discussion took place on October 18, 2011. Abigail was struggling to input her student grades for the upcoming report cards. She asked Emily to demonstrate how to complete the process. While Emily modeled the process for Abigail and Deborah, Christopher jumped in adding tips and suggestions. Again, this conversation was about technology knowledge and the use of technology for administrative functions.

These brief conversations had little to no impact on the teachers' technology beliefs, TPACK , or their actual technology use. As shown in the comments in Table 7, both the frequency and type of technology used in each teacher's classroom remained consistent over the course of the semester. Only Christopher discussed an increase in his use of computers during science instruction:

> In my classroom, I use computers and I use a lot of software computers for different programs, for reading and math. Also but now, this year I'm using a lot of resources software for science. This is great because you can see here my students are writing right here. (Post interview)

He did not attribute this change to the technology-infused lesson study professional development directly stating that the changes was:

> something of a personal necessity or personal desire for being better and also, obviously, those training and meetings that we are having across school, obviously, I learned from that and then everything I can use and I can bring to myself to me as a professional, I will use. (Post interview)

Additionally, Christopher's involvement in the lesson study process was limited. He was absent from the meeting where the research lesson was actually chosen, he did not observe the research lesson, and he was absent again on the meeting that lesson revisions were discussed.

2. *How do teachers in a technology-infused lesson study group change their lesson planning and teaching behaviors?*

Although the technology beliefs and knowledge (see Table 7) and technology use did not change, the teachers did report a change in their lesson planning behaviors as a result of the lesson study professional development. In the post interviews, it became evident that teachers where conflating the lesson study professional development with the Madeline Hunter (1967) lesson cycle. When asked about the lesson study professional development, Bridgette replied, "The cycle, I mean we do follow but we have to pick and choose and see which ones work best with the students that you have in your classroom especially my classroom. We do follow it but not every single step" (Post interview). Even after I tried to separate the lesson study professional development from the lesson cycle (Hunter, 1967), Bridgette stated that participating in the lesson study professional development had made her more aware of planning her lessons using the complete lesson

cycle (Hunter, 1967). She said that after the lesson study professional development, "You become more prepared. You follow the steps [of the lesson cycle]. You know what needed to be introduced, when. That makes you more prepared and more effective if you followed that step by step" (Post interview).

Although the lesson cycle (Hunter, 1967) was not directly discussed in any of the lesson study professional development meetings, the scripted science lesson that the group choose for their model lesson adhered to the seven step lesson cycle including an introduction of new material, guided practice, independent practice, and checking for understanding.

Abigail, Bridgette, and Christopher all stated that they were trying to be more conscientious about using the complete lesson cycle in their planning and teaching during the post-interviews. These responses came from the question, "Do you feel that you changed as a result of that Lesson Study Professional Development cycle in any way?":

> Abigail: Probably, I'm more aware of what I'm trying to get across as a result of the Lesson Cycle but I don't think I've changed a whole lot. I just try to modify and make things a little bit better or a little more easily understood for the children to get. (Post Interview)
>
> Bridgette: You become more prepared. You follow the steps [of the lesson cycle]. You know what needed to be introduced, when. That makes you more prepared and more effective if you followed that step by step. (Post Interview)

> Christopher: I would say yes. I mean I think that this has influenced in a positive way because I have the opportunity to be more organized and deliver the lesson in a better way (Post Interview).

Emily did not feel that the lesson study professional development had changed her planning behaviors, but she did feel that her behavior had changed during the same time period as the study. In casual conversations, she stated that having a student teacher in her classroom may her more conscious of her planning. She was more conscious of her planning in general, not just in her adherence to the Madeline Hunter lesson cycle. In her post interview she stated:

> I've really looked at the scope and sequence. That has laid out the objectives that are expected for both grade levels. And I just - I'm relieved this year more than in any year in the past. I've laid them out side-by-side and taken every objective that I possibly can, and put them together so that I'm not teaching the first grade lesson here and then I need to teach the second grade lesson here...So, I've just been really been able to work with it and I think it's made our days and the lessons a lot more productive. (Post interview)

Deborah did not report any changes in her planning due to the lesson-study professional development of any other factors.

Despite the stated changes, class observations and reviews of the teachers' written lesson plans did not show any differences from the beginning to the end of the semester. This does not mean that there were not subtle changes to the teachers' planning and

teaching. Written lesson plans were not collected from all the teachers, and some of the teachers used pre-scripted lesson plans. The in-class observations may have been too short to capture the entire Madeline Hunter lesson cycle that they teachers said they were trying to use.

3. *Were there features of the group (such as membership, grade level, subject matter, group interactions, etc.) that played a role in the teachers' development?*

The leadership of this group appeared to have a large impact on the progression of the lesson study professional development and the teachers' development as a result of that process. Deborah took a strong leadership role in the team, often creating the meeting agenda and monitoring the time. Using a timer in the first few meetings, Deborah made it clear that she wanted to quickly run through the items on the team's agenda so that she could end the meeting and accomplish other tasks. Making comments such as, "I say we talk about these things and get done in fifteen minutes" (Team 1: September 30, 2011). While the group ignored the timer and some of Deborah's attempts to direct the conversation, the theme of time efficiency still impacted the meetings. In the meetings teachers would quickly change the topic if there was a pause in the conversation. For example, when Deborah was searching through a book for a scripted lesson, Abigail asked, "While she is looking for that, am I that only one that hasn't turned this in?" (September 30, 2011). She pulled out a paper un-related to the lesson study professional development and teachers discussed this paper work until Deborah called their attention back to the lesson study professional development. This multi-tasking and topic jumping behavior occurred in meetings throughout the semester.

Deborah also referred to the lesson study professional development as "Sara's project" preventing the team from ever taking full ownership. In two separate meetings, she turned to me and asked, "Is there anything we need to do for your lesson this week?" (Team 1: September 13, 2011, October 18, 2011). In other meetings, she told the group, "We need to schedule the observation for Sara's project" (Team 1: September 27, 2011). At the end of the semester, Deborah came to me and asked what else I needed from her team in order to complete my study. I told her that I still needed them to complete the written reflection.

The lack of leader and team buy-in to the lesson study professional development process combined with the time pressures dampened rich discussion in this team. Rather than plan lessons collaboratively, the team choose to divide the tasks and to use a pre-scripted lesson. On September 13, 2011, Deborah told me she would take the lead on choosing a lesson for the lesson study professional development in the next week. She was intending to choose a lesson by herself and then present it to the team. Instead, the team chose for Emily to teach the lesson and she was then assigned the task of picking and scheduling the initial research lesson (Team 1: September 20, 2011). Later, in the revision meeting (Team 1: October 25, 2011) Deborah offered to write the revision suggestions down so that they could finish quickly and move to on to the next meeting topic. Emily and Bridgette had not completely finished discussing the revisions, but they stopped the discussion when Deborah started to write up the final revision.

Although Deborah's leadership style may have stifled the rich discussions about planning the lesson, she continually pushed the team forward in the lesson study

professional development. She made sure to add the lesson study professional development to the agenda and pushed the group to set dates and deadlines for completing each step of the lesson study (Team 1: August 30, September 13, September 27, October 10, & October 18, 2011). Pressures of planning for new grade levels, using new writing and science curriculum, balancing other professional developments, and benchmark testing were all in competition with the lesson study professional development. In these one-hour weekly meetings, the teachers were expected to address all of these competing issues. Deborah described this time pressure to the district professional development specialist saying:

> The reason I'm asking is because we have so many things that we can't hardly do, keep up with. So when we meet at this time, you know, like I haven't even started on the [individual student reading assessments] and we have forms that were due yesterday. It's like, uh, if, what we have to do in this time really is get the things [the principal] is expecting of us. (Team 1: Aug. 30, 2011)

Other team members also felt that the meetings were too short. About the weekly team meetings, Christopher stated:

> Well, from my perspective I'll say, the way we are meeting is a good way to meet. It's a good way to share and ask for help or ask for support. It's a good way for supporting each other as a team or grade level team. I think I find - oh not against but not - but I want to say, not priorities at time. We don't have enough time for many meetings. That's a problem.

> Sometimes we have the ideas and the desire for doing something, but we don't have that time for putting into practice or getting all the information, or all the support we expect. (Post Interview)

Because of the time limits, the teachers spent the bulk of the time addressing the most pressing issues. These issues tended to focus on student topics, required paperwork deadlines, and principal feedback. Although originally required by the principal, there were no school deadlines for lesson study professional development, and the principal did not check on the teachers' progress. Without the administrative pressure, lesson study fell to the bottom of the priority list. Deborah made sure that the group at least dedicated some time in their meetings to completing the lesson study professional development by adding it to their weekly agenda.

Another factor in the team's level of discussion was their reliance on scripted lesson plans. All of the teachers on this team were teaching at least one new grade level of students. This required them to plan using a new set of curriculum standards and materials. Additionally, the school had adopted both a new writing curriculum and a new science curriculum. The science curriculum was very scripted and had pre-packaged materials for each lab experiment. The teachers felt tied to these lessons for two reasons: a) time and b) administrator support. The teachers used these lessons to make their planning time more efficient. Three of the teachers (Bridgette, Abigail, and Emily) turned in the scripted lesson plans as part or all of their required weekly plans. In addition to saving time, the principal and other district administrators pushed the teachers to use the newly purchased curriculum. They did this both by publicly praising teachers

who were using the material well and by reprimanding those that were not using the programs. This use of a scripted lesson prevented the group from sharing teaching strategies and collaboratively planning the research lesson. Without the collaborative planning component, teacher buy-in suffered even more. As mentioned in the previous section describing this team's lesson study process, Emily even joked about purposely sabotaging the original lessons so that the revision process was easier.

Montessori Early Elementary Team (Team 2)

The Montessori early elementary team (see Table 8) consisted of four classroom teachers: Kenneth, Lance, Marianne, and Nathan. While most of these teachers had several years of experience in education, Lance and Nathan were both new to the Montessori classroom. Kenneth had experience with Montessori, but this was his first year in a first to third classroom. This meant that three of the four teachers were still trying to master their Montessori curriculum for their current grade levels.

The following sections used information from the teacher interviews and class observations to give a description of each teach prior to lesson study professional development. These profiles look at the teacher's philosophies of teaching, beliefs about technology, and use of technology in the classroom.

Table 8

Montessori early elementary teachers

	Marianne	**Kenneth**	**Lance**	**Nathan**
Grade Taught	1st/2nd/3rd	1st/2nd/3rd	1st/2nd/3rd	1st/2nd/3rd
Students				
Years Experience Veteran (15+) Mid-Career (6-15) Novice (0-5)	*(14)	*(8)	*(2)	*(15)
Available Classroom Computers (#)	3	6	Unknown	4
Reported Classroom Technology Use Tape/CD player				
Projector/ Elmo		X[1]		
Educational Software	X	X	X	X
Educational Website		X		X
Computers for Research	X	X	X	
Microsoft Word	X			
Microsoft Power Point	X			
Blogs	X	X		
Assessment Software				X

[1] X means that the teachers reported using this type of technology in their classrooms.

Teacher Profiles

All of the teachers in this grade level team had multi-age Montessori classrooms. The students in their classes ranged from first to third grade. Under the Montessori paradigm, the teachers should keep students for that entire three-year span whenever possible. As mentioned in the school description, the school was using an Americanized version of Montessori that allowed the teachers flexibility to incorporate materials and strategies into their classrooms in order to meet the requirements of the public school setting. Lance and Nathan were new Montessori teachers. Kenneth had some previous Montessori experience, but was new to the early elementary age level. All of the teachers had an aide in their classes on a daily basis.

Marianne. Marianne had fourteen years of teaching experience, two in a high school computer lab and twelve in a Montessori classroom. Because she had the most experience and had been at the school the longest, Marianne was the team leader. While most of the team meetings are held in her room, she did not take a strong leadership role during the meetings.

In her teaching, Marianne was very focused on her students and their individual learning. She said that it was her job to:

> to give them what they need and then teach them what they need to know in order to grow up to be whatever they want to be in life. They need this foundation. This is very important, even though it's only an elementary school. If you don't do well now, it builds up, and I feel it's very important for me as a teacher to be aware of that and to have that in mind all the time. You've got to do it for them. That's all that matters. (Pre interview)

Marianne used a combination of individual, small group, and whole class lessons to facilitate her students' learning. Students were also expected to take responsibility for their learning and spent a lot of time working on individual Montessori materials. In observations of her class, both she and the students seemed calm and orderly in their work. If they start to get too loud or off-task, Marianne used a small bell to get the class's attention. She did not raise her voice and always spoke positively to the students.

Marianne also came from a technology background. She majored in computer science and worked in the computer software business before teaching. She was comfortable using technology in general but struggled with integrating technology in her Montessori classroom. She stated that she was very comfortable teaching technology skills in the high school computer lab but did not have time to devote to teaching those skills in the elementary class. Marianne knew that technology skills were crucial for her students. "Technology is actually very important because nowadays everything is based on technology, and we as adults are asked to do in order to be competitive" (Pre- interview). On the other hand, she remarked that the "true Montessori" curriculum did not include technology. She felt that the principal was only trying to incorporate technology at Openwood because they were a public school, and the district was emphasizing technology. She wanted her students to learn basic computer skills like Microsoft Word and Power Point, but struggled to balance the Montessori curriculum, state testing standards, and technology.

Marianne only had one teacher computer and two student computers in her classroom. This was less than most of the teachers in the school. She said that she had been offered more computers, but did not have space for them in her classroom. Students used these computers mostly for educational software programs. These programs tracked individual student progress in both math and reading. Some students in her class were also starting to use blogs as a way to publish their "research". This blog use was initiated by a student, not by

Marianne. The student had asked to use the blogging tool that she used at home. Marianne liked the idea and then said that other students wanted to learn as well. Marianne allowed the girl to teach other students in the class how to create a blog. This activity was discussed in the post interview, and I did not get an opportunity to observe it in practice.

With twelve years of teaching experience in an early elementary Montessori classroom, Marianne had the most experience by far. Because of this, the other teachers often called her "the expert" and asked for her help and suggestions during the team meetings. However, Marianne always responded humbly, and did not offer any more suggestions than the other teachers. Marianne often seemed discouraged in the weekly team meetings. She mentioned feeling "tired" and "overwhelmed". She even joked about leaving teaching because she was so tired and stressed. Some of her teammates also noticed that she was stressed and mentioned it to me in their interviews.

Kenneth. Kenneth had 8 years teaching in a Montessori classroom, but had lots of other life experiences teaching and working with children. He felt that:

> Some people just love to transfer knowledge, transfer skills and take delight in it. Teaching to me is more of an avocation, not a vocation. It's a hobby. If I had millions of dollars I'd do this for free. I would be a teacher just because it's so pleasurable. It's so wonderful to see the light go on. (Pre interview)

Most of his formal teaching experience had been in a Montessori classroom at the early childhood level (Pre- K through kindergarten). During the study, he was in his first year as an early elementary Montessori teacher.

Kenneth was talkative and candid throughout all of my interactions with him. He was opinionated and uncensored about teaching and about technology. In terms of teaching, Kenneth was adamant that Maria Montessori was brilliant and that her curriculum was the most beneficial for student learning. In his pre-interview he stated that, "Public education is the illness; Montessori is the cure". He went on to explain why Montessori is the "cure":

> A lot of really dedicated people have tried to discover a way to make…really educating children work, and Montessori just already does that. So the joy of being a Montessori teacher is so profound. You get to have the children for three years. You have a learning society. When new children come they become part of your learning society, rather than you're a fourth grade teacher and here come the children who have been together since kindergarten and they are in cahoots and each year you've got to face a new wave of children with their own way of dealing with teachers and trying to put the teacher in their place. (Pre-interview)

He continued his comparison between public education and Montessori discussing the history of publication education in the industrial revolution and the differences among children that he felt public education ignored. He also used recent research to emphasize how many of Montessori's theories are being confirmed by brain studies today.

Kenneth did not see technology as an opposition to a Montessori curriculum, but rather an important complement to his curriculum. He speculated that if Montessori were living today, she would have invented a technology rich "robotic" classroom. He saw technology as a way to differentiate and individualize instruction for his students. Kenneth had grand ideas about the ways that face recognition, temperature sensors, and tracking software could be used to create a classroom where data collection was ongoing and computers with artificial intelligence provided immediate information to help teachers target student misconceptions. He was disappointed that with all of the technological advancements in our society, educational technologies were neglected. His sentiments are evident in the following quote:

> I cannot tell you how frustrated I am that there is software to sell people things, there is software to track stock markets and you can sign on and get on a website and have all this software and all this hardware at work on you. I mean there's more technology in a cell phone which you can point, GPS tracks, stand anywhere, point at a building and it knows where the nearest place is to get an ice cream soda or it'd give you a choice of three. And it's just phenomenal that the education of our future generations is not worthy of that kind of investment. (Pre-interview)

In his classroom, Kenneth used computer software programs that track individual student progress, but his technology use was limited by the school resources. In regard to technology in his class, he remarked, "I love it. Give me more. Give me a million dollar grant. You'll see some action here" (Pre-interview). In addition to the software programs

provided by the school, Kenneth used Microsoft Power Point to make electronic flashcards for his students to learn vocabulary words. The computers in his classroom served as a work station and counted as individual student practice. Students were able to choose a computer software program for their math or reading lessons, but were not required to use the computers. This caused some students to spend lots of time on the computers, while others rarely chose to use the technology.

Kenneth also had a projector in his classroom, but struggled with the best way to utilize that technology. In his pre-interview he gave on example of how he wanted to try and use that technology in a more student-focused way:

> I would do more with my projector but you know something, the priority is the individualized learning of every child and the projector is a kind of a whole group event. So I've yet to bridge the gap between small-group and individualized learning with the technology I have available. Once the projector is on, everybody's brain just shuts off and they all stare at whatever I'm doing. But I'm planning on using it with a new terrarium that we're going to replace this terrarium with one even better, or the real deal and we're going to move all of our reptiles and animals and such and plants into a new terrarium. I want to have that camera focused on it and it will be running full time. Students will be able to do their observation and zoom in and out. (Pre-interview)

The terrarium and projector were not set up during the time that I completed my observation. In the post interview Kenneth discussed how difficult it was to get the

technology resources that he wanted in his classroom. During the observations he had six computers, but he mentioned that he had begged for these computers. He described the process of getting more computers as "like having a tooth pulled through your ear. This has been no fun." (Post interview). With his computers he was planning to have the students improve their writing and spelling by teaching them to type journals in Microsoft Word and make informed decisions using the spell-check function.

Since his post interview took place very soon after the benchmark scores were released, Kenneth focused a lot on the test and how he was trying to improve his students' scores:

> I don't have in place what I need. My response to the benchmark is get as many computers as I can get in here, crammed into this little room and get as much stuff that teaches what they need to know on the start. Huge transition because I was all about getting Montessori rolled out. (Post interview)

Kenneth did not feel prepared for the new district and state testing and was having a difficult time trying to learn merge the early elementary curriculum with the district test. He found this especially difficult because he was new to the age-level that he was teaching and was still struggling to learn the curriculum and expectations for the first through third graders. He explained that there was some contention among the Montessori teachers about which textbooks and software, if any, were appropriate in the Montessori classroom. He claimed that he tried to get the other Montessori teachers to help him create test prep materials that aligned with the Montessori curriculum, but that

no one was willing to take the extra time. His response was to use the materials the school was providing to supplement his Montessori materials. Despite his strong beliefs in the Montessori curriculum, Kenneth had a very practical outlook on the testing and its importance for his class.

> We need to be a real Montessori, right? Well, if you we don't pass - here's the reality: If we don't pass the test, we're not ever going to be anything except public. We're just going to be over, so I'm justifying to you because I just want people to know that I gave the experts, the Montessori experts, the opportunity to assemble something so that I could do it too without having to try and dredge it out of the Montessori materials that I'm trying to learn and create a system so that they learn all the public stuff, okay? Send me your lesson plans or help me understand how to track it and do the whole thing and I'll do it, and they didn't. And so no fault to them; they don't want to work an extra four hours a day. (Post interview)

Kenneth felt that if the Montessori students did not perform well on standardized tests, the program would be cut. He wanted the "Montessori experts" or the teachers with the most Montessori experience to get together with the newer Montessori teachers to create materials that would bridge the gap between the standardized tests and the Montessori curriculum. He reiterated this idea that passing the test was a necessary evil several times in his team's meetings.

Similar to his strong beliefs about public school education, Kenneth felt that teacher professional development needed a complete overhaul. Kenneth complained that each year they had more trainings to attend, but that the teachers were not given an opportunity to put what they learned into practice.

> I think there's like each year, they add more trainings that you have to go to when you ought to just be working in the classroom with what you know. At church, we call that training beyond your obedience. I'm already trained beyond my obedience, my capacity to fulfill that which I know is true and yet I have to go to more trainings and then they give me more programs. So this is actually getting worse, not better. (Post interview)

He described this approach to teacher professional development as a "buffet".

> They hand us the buffet approach. I'm going to have a little bit of this, a little bit of that, a little bit of this, a little bit of that, now you choose. Who does that serve? Does that serve the children? Does that serve me? I get to choose from all these things like a buffet and then I have to take that all together and feed it to 22 kids, right? (Post interview)

He wanted the school to stop offering him so many different workshops and instead offer more tailored in depth classes. He believed that these should be college courses, and that teachers should receive credit for taking the courses.

> I should never ever, ever be asked to go to any training that does not carry college credit. I don't know who invented this ongoing study routine but I

have had so many pointless, muddled trainings where it isn't adapted to what I do at all. …So it should never be anything less than college credits. If I just go to a few good college courses that are tailored to what I do. No more $2.00 shoes that hurt my feet. Good pair of shoes that really fit me. Good training that really fits me. Put me on a career path, and I think the district is talking about this…Put me on a career path, and let me go to college classes that get me there. (Post interview)

He also felt that the teachers were often treated as one step above students rather than as professionals in their field.

We're not one step from children. We are the top, and everybody else should be in service. Now, I consider myself a servant leader. Have you ever seen a triangle - yes, the rich guy at the top telling everybody what to do? Everybody serves him. Now, I'm a servant leader. I'm at the bottom of the pyramid, and my job is to serve all my students and my peers as best as I can and show leadership by being a servant. At the same time, those who would say they're leaders to me need to be ready to serve and not come and tell me this and tell me that and tell me some other thing and to pass down mandates and not really know what's going on. They need to just sit back and relax and listen. They're waiting for us to tell them we'll get together, all our peers. My peers and I will get together, and we'll tell them what we really need and what we want. Then they should

do it because after all, that's what we've been trained to do, help people do the right thing. (Post interview)

Although his group was not able to complete the lesson study, Kenneth thought that the process would be worthwhile. He was very happy about the collaboration that was occurring in the weekly team meetings. He felt that even though there was a lot of stress related to the new standardized tests, the growth of the Montessori program and the new magnet classification, the teachers were more collegial than in past years. He seemed to crave more collaboration with other teachers, and in meetings he often suggested working on new ideas as a group. He was naturally talkative and was a dominant voice in the team meetings.

Lance. Lance only consented to one interview and recording his involvement in the weekly group meetings. He was only in his second year of teaching and first year in a Montessori classroom. He did have some previous experience as an aide in a Montessori classroom, but was having a difficult time managing the new curriculum, a multi-age class, and the standardized tests. His interview took place toward the end of the first semester after the group had attempted to engage in lesson study professional development, and had a more negative tone than most of the other interviews. Several times during the interview, he mentioned being "overwhelmed".

One reason he may have been overwhelmed was the pressure that he put on himself as a teacher. He viewed a broad role for himself as a teacher. Lance felt responsible not only for his students' content area learning, but also for their emotional

well-being. While other teachers tended to describe themselves as "facilitator", Lance classifies himself as a, "Classroom manager, psychologist, and life coach" (Interview). He tried to set up routines and procedures "to motivate the students to do their best" with a goal of "[helping] these young children to feel okay about themselves" (Interview). This view of having to be "everything" for his students, paired with his inexperience, caused him to be more stressed than some of the other teachers at the school.

In addition to the daily classroom responsibilities, Lance missed several days for required professional development workshops. When asked about his professional development, he replied, "What haven't I developed? I mean, really - I mean it's been just nonstop" (Interview). He went on to say that the professional development workshops he attended were good, but that "more information isn't necessarily what [he needed]". Lance described the professional development as "overwhelming" and felt that he did not necessarily know how to implement the information from the training, or have the time to do so.

> I don't have a lot of time outside of the classroom, and that's really what, to do this successfully, that's really what you have to do. You really have to spend a lot of time planning out all these little details. There's a lot of detail, a lot of details in this job. (Interview)

For Lance, teaching was a second career. He had switched to teaching from a technology career as a way to slow down but was not finding teaching to be what he had expected.

Another source of Lance's stress dealt with balancing the Montessori curriculum in a public school setting. This was especially hard for him as a first year Montessori teacher.

> To have three different grade levels in here and to have all this focus on this new big [state standardized] test for my third graders and all these other programs going on, it's - and then for me, and like several other people here going through their internship year in Montessori where you're really trying to follow exactly what we just came out of and trained, but kind of having these different camps pulling and pushing with what's important and what are we doing. On one hand, which is to have our objectives posted in the room, but on the Montessori side, to waste time on things like that would be ludicrous. I mean you would spend every second in the classroom during your work time giving lessons and helping students, and there's just not a lot of strong correlation between the two programs and in the past, we kind of - as a program within the school, we had a certain amount of just - we were cloaked a little bit. All eyes were on the Montessori classrooms, and the Montessori classrooms tend to draw a certain style of family and student, now that's changing. So, we're dealing with a lot more of the classroom management issues. (Interview)

The growth of the Montessori program within the school meant that the school's test scores were more dependent on the Montessori students' scores. Unfortunately, these

students did not perform well on the benchmark testing. Both the principal and her district supervisor were concerned. They placed additional pressure on the Montessori teachers, and Lance felt that pressure.

Coming from a technology background, Lance was very comfortable using technology and stated that it was important for his students to be able to use technology. However, he did not think that many of the educational software programs provided by the school were consistent with a Montessori curriculum. For that reason, students in his class were able to use computers during their Montessori work time only for research or one reading intervention program. Students were only allowed to use the other educational software after they had completed all of their Montessori work for the day.

In terms of the school technology use, Lance thought that they were moving in the right direction, but that the implementation was still lacking in some areas. While most of the other teachers were asking for more computers in the classrooms, Lance felt that there needed to be more human support for the technology implementation on campus.

> Well, it seems a little haphazard. I mean it seems like it - I mean I know it's a focus, but we just really need somebody who can really drive all that, and so to have a technology person who's also spending 90% of their time teaching ancillary classes, it's going to be very challenging for the teachers to spend the time and figure out what to do to get certain pieces of software up and running, and set up systems, and solve problems, and we have issues and then you have to take time to call the help desk and so to coordinate all that for teachers is very challenging. (Interview)

Aside from the hardware and human support, the school technology policies also affected which programs Lance used in his class. He, like the other teachers at the school, used the programs that were licensed by the school or district.

Email was another way that Lance used technology. He complained that he was sent too much email and again described it as "overwhelming".

> I could spend every [weekly team] meeting sitting at my computer going through all the e-mails I get, and trying to process which ones I have to deal with, which ones can wait. I mean I could have a to-do list like this, and it's just kind of gotten to a point now where if somebody's not barking up my tree, I'm just not worrying about it. That's kind of unfortunate that it gets to that point, but it's just too much. There's no filtering, it feels like. So, we're just spread too thin. (Interview)

Like the professional development, email was just another form of information overload for Lance.

Lance described his weekly team meetings in the first semester as "teacher support groups" that were not very productive. He compared this to his previous school where "it was really more of a way to share what you're doing". He said that this sharing helped him to focus on what was working and ways to improve. Although he missed several of the team meetings during the second nine weeks due to professional development, he expressed to me that the mood had changed in the team after lesson study professional development was introduced. His explanation was:

> That we could just talk openly and discuss things without any agenda necessarily, and maybe we - I don't know. So, I think having all the suddenness, this focus, another outside person coming in, definitely changed the energy or the dynamic that was there. It definitely changed, and it kind of became another - I mean PLC is almost - I mean, it's our break on - I mean, really, we have our meeting when we're supposed to have our planning period, which is a 45-minute period where we're able to do what we need to do, and so then they have a PLC meeting where now you're given another project or something else to think about, or something else to have to process. I think it's challenging. I think it was just, even though it seemed simple, we're just so at the edge to add anything else. It just feels kind of overwhelming. (Interview)

For his team, the lesson study professional development was introduced just a few weeks before the benchmark testing. At this same time, the teacher meetings were all moved to the office and were led by the principal which could have also contributed to the change in participation and the atmosphere during the meetings.

Although Lance felt that the lesson study professional development changed the tenor of the group, he saw it as a worthwhile exercise in theory.

> I think that's really good professional development…I think that's the kind of thing that would really be beneficial, but again people are just so overwhelmed and I can't- it's hard to get my mentor teacher to come and interact with me with anything. So if there was something set up to where

> we had to do these things, I mean I think it's crazy that we're not utilizing more of that style, really, where the more seasoned teachers who have been doing this for ten, twelve years would facilitate in developing specific lessons or going over lessons. (Interview)

Lance went on to explain that lesson study professional development could be particularly helpful in Montessori where there was more freedom in the curriculum for teachers to pick and chose how they would implement the curriculum to best serve their students.

Nathan. Nathan had fifteen years experience in education. He had taught at both the elementary and high school levels. He also served two years as a high school assistant principal and two as a head principal. In order to get out of the high school environment, he took an assistant principal position at Openwood. Last summer, the assistant principal position was downsized and Nathan decided to go back into the classroom as a Montessori teacher. Openwood was his first experience with a Montessori curriculum, and he liked that the curriculum encouraged critical thinking. His class was one of two bilingual early elementary Montessori classes in the school and the only bilingual class in this team. Nathan consented to the interviews, class observations, and participation in weekly team meetings. His class was observed and his contributions in the meetings were recorded. However, only one interview was obtained due to scheduling conflicts. This interview took place near the end of his team's lesson study professional development.

Nathan's experiences at the high school level influenced how he viewed his role as a teacher. He believed that his students needed to enter middle school "two grade levels ahead," and it was his goal to push them in that direction. He felt that if the students were ahead of the curriculum when they entered middle school, they would be less likely to drop out in high school. He wanted his students to be critical thinkers and did not agree with a top down approach to education. "I want to make a vision for the child so he can think outside the box down the road, and that's what I want" (Interview). While Nathan saw critical thinking as one strength of the Montessori method, he also mentioned that there were deficits to the system. He had observed teachers both in his school and in others using reading materials that were not appropriate or that were too easy for the students. He supplemented the traditional Montessori curriculum with more direct guided reading lessons and writing workshops. Both of these were techniques that he had learned during his master's program.

As a bilingual teacher, he also stressed English language skills. He asserted that his third grade students were capable of taking the standardized tests in English and he wished that they were allowed to do so. He felt that practicing for the test in Spanish, when they would need to test in English the following year, was counterproductive.

Nathan enjoyed working with students who others classified as "difficult". He used positive encouragement and high expectations to push struggling students to succeed. He was strict with these students, but always respectful. He also said that he "never gave up" on these students.

> I never yell at them. I never say they're stupid. Nothing. I just keep working with them and keep working with them. Sometimes I have to calm them so they won't hurt anybody…I'm firm with them. They understand that. They can't get out. I keep them there for five minutes and I'm like, "Okay. Are you ready to learn now?" (Interview)

Because these troubled students were so difficult for other teachers, Nathan found it rewarding to be able to help them succeed. He offered several anecdotes of students that he had taught in the past.

In terms of technology, Nathan stated that he "tried to use it as much as [he could]", and that he used it "quite a bit." Nathan viewed technology as a "resource" but said that it was "never going to replace the instructor" (Interview). He thought that a teacher was needed to guide the students and to assess their learning. The teacher could then use technology to help the student improve on specific skills. On the other hand, technology should not be used as the sole curriculum for a class. He described his technology use:

> I use it as a resource but I teach to listen, do hands-on, do questions hands-on, and then I'll put them on the computer for them to practice. And then they have to write, what have you, and then they get it. Then they test it. (Interview)

Like other teachers, Nathan used online software to supplement his other class activities. However, Nathan was not satisfied with the programs that the school and district purchased. He used several free online software programs and even paid the

license fees for one program that he wanted his students to use. Nathan also used the district test bank software to create common assessments for his team when the benchmark test scores were too low. He did this voluntarily and seemed very comfortable using that program. After he created the first test, he wanted to train other members of his team to make the tests so that they could all share responsibility. Nathan did not want to continue to make the tests by himself, because he did not think that other teachers would use them if they were not involved in the planning. Nathan said that:

> You can give them information all day long and they're not going to use it. They won't use it unless they're involved in the planning, like they're planning three weeks ahead and all that with you. They won't work. Assistant principal, even as the principal, you give the people so much and you do this and you do that for them and then not only don't they appreciate it, it becomes overbearing for them. (Interview)

Nathan reiterated the idea that you cannot force information on teachers without them either asking for the information or including them in the planning in some way several times throughout the interview. He also demonstrated this in his interactions with his team. As the former assistant principal, Nathan was very cognizant of the way his peers might view him. He purposefully held back his comments and suggestions in the team meetings. He described his role in this way:

> I want them to try to come up with it. I'll try to push it but I think it has to come from the team members. You know what I'm trying to say? I don't want to say, "Hey, do it like this" and they end up hating me, or they

won't work with me, or they just totally ignore me. What I'm hoping is to slowly get in there and, I wish it was different but knowing personalities and everything else, you really have to work in that way. Otherwise, you get the team to hate each other and nothing ever occurs. (Interview)

Nathan wanted his team to have more focused meetings with a stronger leader, but he did not want to be that leader. "I don't want to take over the meetings. You know what I'm saying? I'm trying to be the one low key, the one in second or third tier." (Interview) He predicted that with the right leadership, his team could be a "super team" sharing information and working together to really help all of the students learn and achieve.

Nathan's main form of professional development was the Montessori training program. He had learned a lot of strategies and theories in his graduate program, and was not impressed with the "knowledge level" professional development that he was sometimes required to attend. Most of his views about effective teacher learning came from his experiences as an administrator. He felt that if teachers were given too much unsolicited information, even very good information, it could become "overbearing". Several times during the interview he mentioned the need to lead by example and then wait for the teachers to seek out help. Simply providing information did not lead to actual teacher change.

Like the rest of his team, he felt that lesson study professional development "would be great", but that you have to have teachers willing to participate. According to him, his team was not successful in lesson study because they lacked leadership. Another

reason for the lack of participation in the lesson study professional development was the fact that the teachers on his team felt overwhelmed by testing.

> It is overwhelming right now for everyone because everybody's job is on the line and everybody's trying to do their best but sometimes, like my friend said, you have to know what to teach. A lot of people do not know what to teach to get to that point. (Interview)

Later in the interview he described the teachers' as being "under extreme duress", "scared", "nervous", and "under pressure". These feelings stemmed from the thought that if the school was unable to get acceptable standardized test scores, the district would cut all of the Montessori classrooms. This was extremely stressful for teachers who were still trying to learn the Montessori curriculum and align it to the new state tests.

Lesson Study Professional Development

This team started the lesson study professional development in the second nine weeks on October 13, 2011 (See Figure 4). The team had been meeting weekly during the first nine weeks, but had not been introduced to the technology-infused lesson study process. It took three attempts to get all of the teachers present at a meeting to explain the lesson study professional development. The first attempt failed because the teachers all had other things that needed to be accomplished during the scheduled meeting time such as: getting new furniture for their classrooms, grading student work, and planning for the following week. In the second meeting, on October 20, 2011, I explained lesson study professional development to Marianne and Kenneth. Kenneth was very excited about the fact that the professional development was adapted from Japan and signed his consent

form immediately. Marianne was concerned about having time to complete the cycle with all of the other school responsibilities, but also agreed to participate.

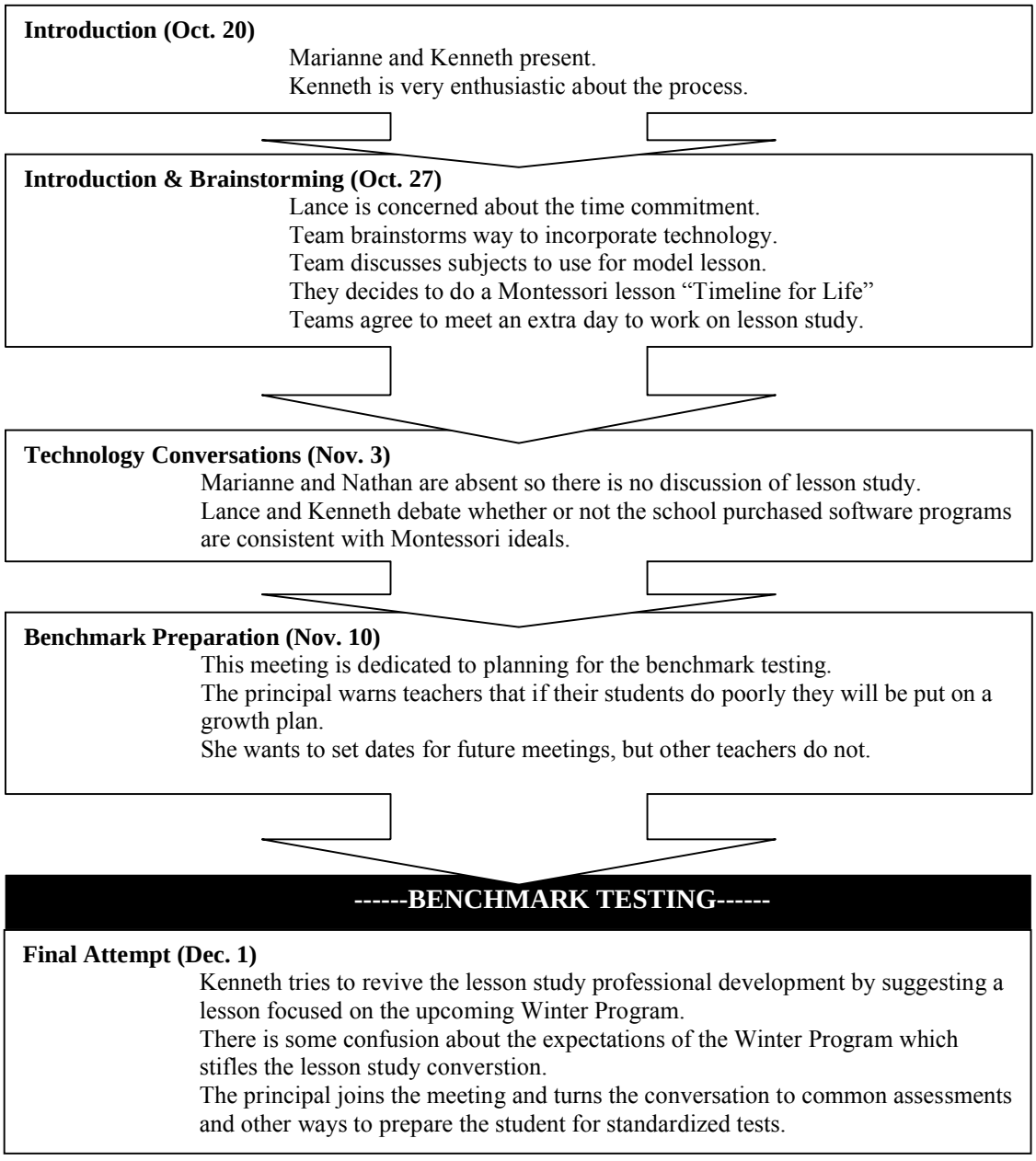


Figure 4: Team 2: Lesson study professional development (October 13-Dec.13, 2011)

In the third week, all teachers were present in the meeting. I reviewed the lesson study process. Like Marianne, Lance was concerned about the time and wanted to have

the entire school year to complete the lesson study process. When I reminded them that they needed to finish by the end of the semester, the team decided to immediately start on the lesson study process. All teachers consented to the lesson study professional development, and the team began brainstorming ways that they would integrate technology in the classroom. The first examples were teacher-centered technologies such as online videos and PowerPoint. Kenneth, Nathan, and Lance were all actively making suggestions. Marianne was listening, but did not make any suggestions. Nathan suggested that they think about ways that the students can use technology and the conversations turns to more constructivist student-focused activities such as student created Power Points and filmed student presentations. Kenneth agreed that having the students use the technology was a good idea, but also pointed out that getting the students prepared to use Power Point would be time-consuming.

The conversation then turned to choosing a subject matter and specific lesson in which to integrate technology. Lance suggested that the team use an upcoming whole-group Montessori lesson, "Timeline for Life", for the lesson study, but the team was concerned that they would not have time to incorporate the technology before they needed to teach that lesson. That whole class lesson was to be taught within the next two weeks. In the previous meeting with Marianne and Kenneth, I had mentioned the principal's suggestion to use a writing or science lesson from one of the new curriculums. Kenneth remembered this and suggested a lesson from the new writing curriculum. The teachers were not yet using the new writing curriculum, and Lance wanted to master it before he was expected to start the new science curriculum. He had started to use pieces

of the writing curriculum, but struggled to integrate it into his Montessori class. Since this team taught under the Montessori paradigm, they were expected to adapt the new writing and science materials to fit within their classes. Marianne brought up using the new science curriculum, but the other team members were not as interested in this subject. Finally, as the team was running out of time they decided to focus on the Montessori lesson "Timeline for Life". Since this lesson was so soon in their lesson plans, the team agreed to have an additional team meeting two days later to work on the lesson study professional development. Due to scheduling conflicts and other obligations, this extra meeting never happened.

The following week, Marianne and Nathan were absent due to other professional development. Lance and Kenneth decided not to discuss the lesson study professional development without them. Instead, Lance and Kenneth debated whether or not the school-purchased math and reading software programs were consistent with Montessori ideals. Kenneth felt that because they were tracking individual student process and providing immediate feedback the programs were an appropriate supplement to the Montessori materials. On the other hand, Lance questioned the movement of the students away from concrete manipulatives too soon. This conversation was not directly related to the lesson study professional development, but could have been influenced by my presence even though I was not part of their converstion. Kenneth was excited about technology use and spoke about his ideas frequently when I was around.

Lesson study professional development was postponed during the next two meetings (Team 2: November 10, November 18, 2011) while district benchmark testing

took precedence in the meetings. The principal joined the first meeting, which revolved around planning the logistics of the benchmark test. Since only third graders took the test, and teachers are only allowed to test a few of their own students, the teachers had to create a schedule for the test days. After the group spent twenty minutes discussing the schedule, the principal assured the teachers that she would create the schedule. She urged the group to focus on ways in which they could help their students perform well on the test. She informed that teachers that she received a district mandate that all teachers who do not have an eighty percent passing rate in their classes would be placed on a teacher growth plan. The growth plan was tied to the district's teacher evaluations and required teachers to undergo targeted professional development. In this meeting, the principal was stressed and stated, "I have a great anxiety about the test since I just came from that meeting. I am just passing it on to you."

Unfortunately, the school did poorly on the benchmark test, with almost all of the classes receiving a failing overall class average. The teachers were not placed on growth plans, but the principal moved all weekly teacher team meetings to her office so that she could lead the conversations. These meetings (Team 2: November 11, December 1, December 8, December 16, 2011) centered on ways to improve the students' scores on future standardized tests. On November 11, 2011, the principal explained that the teachers were now required to post objectives, have common weekly assessments, and note student interventions in their weekly lesson plans. In subsequent meetings (Team 2: December 1, December 8, & December 16, 2011), the principal reiterated these requirements and asked the teachers about their progress. The teachers in this group were

very involved in these conversations. For example, they often asked clarifying questions and offered suggestions for improvement. Table 9 shows examples of clarifying questions that were asked by teachers in the meetings.

Table 9

Team 2: Examples of clarifying questions

Topics	**Example of clarifying conversations**
Objectives	Kenneth: I thought they were supposed to be daily, weekly objectives. Not like overall extended objectives? Kenneth: So we could collaborate across our grade level, lower ele., and we should all have the exact same bulletin board [for the weekly objectives]. Montessori Coordinator: No, not necessarily. Kenneth: Well, I think we should. All eight people should get the work done and…(Team 2: November 11, 2011)
New Curriculum	Lance: Who is using Empowering writers? Principal: This entire campus. Lance: No, I'm asking, because I've pulled it out and I'm struggling to try and implement it. So I'm wanting to know who is doing it and using it and can answer questions. (Team 2: November 11, 2011)
	Kenneth: I need to see what you're doing with Reading Street. (Team 2: December 1, 2011)
Homework Requirements	Lance: So homework is, um, I mean I've got a standard homework that's the same routine every week, Monday through Thursday, including Friday actually. They take their spelling tests home and write the words they missed. But it's not changing from week to week other than the words. The high frequency words and the spelling words change, but the routine is the same. Is that… Principal: What do you, do you think it's supporting your kids? Is it effective? Lance: Really, what I'm sitting here thinking about is that it is certainly good for first and probably second. And with third I'm starting to think that I want to have some more specific, you know, comprehension skill practice. Principal: Yeah, I agree with that. (Team 2: November 11, 2011)

Lance and Marianne voiced concerns about maintaining the fidelity of the Montessori curriculum while balancing the new expectations. Marianne said, "But we're

not doing any Montessori anymore. With all of the things we are doing, Empowering Writers, Envision Math, where is the Montessori? Let's just turn into traditional already" (Team 2: December 1, 2011). On the other hand, Kenneth and Nathan seemed to approach the tests as a "necessary evil", and both believed that they could prepare their students for the tests while still adhering to the principles of Montessori. Following a group discussion about how the Montessori students need more practice taking an assessment, the group had this conversation:

> Lance: But that's called traditional public school, so it's really confusing to…
>
> Montessori Coordinator: So maybe once or twice a week we need to come up with an assessment that we practice.
>
> Kenneth: Well, they have to pass the test. I don't care what you call it.
>
> Nathan: Maybe once a week, do it every Friday.
>
> Principal: Well, I don't want to take away, and I'm not suggesting that we take away a four hour block every week or every two weeks.
>
> Nathan: No, it could be 2:00, from 2:00-3:00. (Team 2: November 11, 2011)

On two separate occasions (Team 2: November 11, December 1, 2011), the principal assured her teachers that she believed in the Montessori curriculum and was "committed to Montessori with fidelity" on her campus. She challenged the teachers to set an example for other public schools wanting to move to a Montessori curriculum.

> We've got an opportunity to implement Montessori in an authentic way. We just need to make sure that our kids our successful and I don't think there' a reason why we can't do it. I believe that a Montessori education can be every bit as rigorous and relevant, the depth and complexity it there, but it's really hard work. And as a teacher, I don't know how you do it. Because it's about you know keeping up with every single child, it's about managing your assistant. It's about go, go, go, go, go every second. It's a lot. It's a whole lot. But we have to realize it's for our kids. And you know, we are a small group, public Montessori's. You know out of 40,000 public schools there are now less than 300. At one point that number had been growing, but the latest number I saw on was less than 300. So we are a very small group, but we have a phenomenal opportunity to do something ground breaking and something transformative for public education. We have this opportunity and we just have to figure out what it is that we've been missing. And I really do think that it's the standard's based piece. That's our accountability. I know that I walk into your classrooms and I see dynamic things happening. But what we have to get to is being smart about those connections to the accountability pieces. (Team 2: November 11, 2011)

The tone of the last four weekly team meetings was more urgent than the beginning of the nine weeks, and the teachers seemed to try to pull together as a group. They began to ask for help with specific subjects or class issues and share materials that

they were using in class. Despite this questioning, most of the suggestions tended to be surface level suggestions, such as "use Empowering writers", or ask "more level one and two questions". The team did share their resources and formatting for the Montessori student work plans, but they did not collaborate on specific lessons or discuss how to use the materials that they offered each other. Nathan repeatedly called for more collaboration. He wanted the team to come together to create common assessments, lesson plans, and even student materials:

> But I think the solution is easy. This is just me, maybe you guys have, if we are proactive and just maybe work together and come up with an assessment. Say okay, we are going to work on this objective this week, and not give the kids the answers, but work with them so that they can master it, with the homework. If we could break it down where somebody is in charge of the homework, somebody is in charge of the assessment, and somebody's in charge of the lesson plan, and then work it up. I can do the assessment, because it's easy. Or maybe if someone could come up with level one questions, things like that, but work as a group. (Team 2: November 11, 2011)

Kenneth always agreed with these suggestions. Marianne also agreed that Nathan's ideas for collaboration were important but did not volunteer to help. She did not volunteer even when she was asked directly to help create classroom materials because of her expertise in Montessori. She never said "no" directly, but rather deflected the question.

Nathan: I can do level three [questions] all day long, but coming up with level 1 and 2 we've got to work together to come up with it. Marianne has the most experience.

Kenneth: You have the most experience.

Marianne: You have the same as…

Nathan: Marianne is like a doctor in this thing, Man.

Marianne: Be quiet.

Nathan: She could do surgery.

Kenneth: Yep. Dr. Marianne, brain surgery.

Marianne: You guys are trying to make me feel better, but it's not going to work. (Team 2: December 1, 2011)

Lance was absent from several of these meetings due to other professional development workshops.

In the last two weeks of the semester, Kenneth tried to revive the lesson study professional development with his team. He suggested that the team use the computer and projector to teach the songs that their students would sing in the Winter Program. He had already started using the method, so they did not need to plan as a group. While this suggestion skipped a key step in lesson study professional development process, I encouraged the teachers to work together to complete the rest of the process. Nathan suggested that they could add more technology to the lesson by using a YouTube video of the song rather than just a recording:

Kenneth: The strategy is project it with your media projector. And then they learn the song, looking at it on the media projector screen.

Nathan: I could put it, uh, YouTube, and then…

Kenneth: YouTube won't work here.

Nathan: Yeah, it does, if you upload it on your own player, on your own computer. I put it on my laptop.

Kenneth: Oh.

Nathan: You can do it like karaoke. (Pulls out his iPhone) I want to show you how it works. It has the words.

Kenneth: I used to have real player on a phone a long time ago.

Nathan: No, no you put "karaoke" and whatever song you want and it will come up with the music and the words.

Kenneth: On YouTube? Wow.

Nathan: Yes, want me to show you?

Kenneth: No, not right now. No, my brain is so full. It's full to bursting.

Nathan: I've got it on my phone. (continued to look up a song)

Kenneth: Well, I'm not a smart phone guy. I'm a dumb phone guy.

Nathan: What song do you want? (Team 2: December 1, 2011)

Marianne entered the meeting late, but when she entered she informed Kenneth that he was teaching his class the wrong song for the Winter Program. There was some discussion about which song the students were supposed to sing. At this point, the discussion of lesson study professional development ended. When the principal entered

the meeting, the conversations turned back to common assessment and student progress. This team did not discuss lesson study professional development again.

Research Questions

1. *How do teachers in a technology-infused lesson study group develop (a) their attitudes toward technology and (b) their technological pedagogical content knowledge (TPACK)?*

These teachers did not get past some initial brainstorming in their lesson study professional development. These short brainstorming sessions did not result in any changes in their attitudes toward technology or their technological pedagogical content knowledge due to the lesson study professional development (see Table 10). Even Lance and Kenneth, who had a long debate (Team 2: November 3, 2011) about the correspondence of various technologies to the Montessori curriculum, did not change their views about technology in the Montessori classroom. Both of them left the conversation still believing in their initial viewpoints. This was evident in the way that they used technology in their classes. Kenneth, who believed that technology and the Montessori curriculum were highly compatible, decided to use individualized software programs frequently as part of the students' regular work plans. On the other hand, Lance felt that the software available at the Openwood Elementary pulled students away from the concrete Montessori manipulatives too soon. Lance chose to use these software programs only as an extra activity that students can complete after they had finished all of their regular Montessori work. Both teachers felt that use of the computer for research was in line with the Montessori curriculum and allowed students to use computers for this purpose during their daily Montessori working time.

Table 10

Team 2: Technology beliefs pre- and post lesson study professional development.

	Comments About the Role of Technology in Schools	
Teacher	**Pre-Interview**	**Post interview**
Marianne	Technology is actually very important because nowadays everything is based on technology, and we as adults are asked to do in order to be competitive …in order to do the, like to be on top of things, you've got to know, you've got to be literate in technology. You have to know how to use a computer. You have to know not only the basic stuff on the computer, but also learn how to create documents that are going to help you in your job. Everybody has to do that. Nowadays, everything is based on technology to make it easier for us as humans because if we all have to do all the work by hand, it will take a longer time and it will be a lot more effort. So technology is important and it's integrated in any kind of curriculum that you do. Montessori - the genuine, traditional Montessori doesn't have a lot of technology, but since we're in a public school, we have to be on, as I said - I mean, not only competitive, but to be at the same level as everybody else. I mean, we need to learn and teach the children how to use the computer and how to create their own documents, graphs or presentations, and I think it's important. I mean, I wish we had more time to actually teach more of technology. Like I have a background in Computer Science. I mean, that's my major. I try to teach them only; you just got to learn the basic stuff in technology. Like how to use a computer, how do you turn it on and off and how to log in and basic keyboard things. I mean, using the keyboard so that when they do a presentation, they are able to actually publish their work. I'm trying to teach them like blogs.	We're doing blogs, like a little bit of software that we already have in the classroom that it's already installed in the computers, like FASTT Math. We do Imagine Learning; we do Accelerated Reader; we do starfall.com, which is just a website for them to practice their reading skills. They do it independently. They do have an assigned time and they just - at the beginning, of course, I have to teach them how to use - and I introduce whatever we're doing, and I give them passwords and everything, and then they do it on their own. When they need to take a test, I mean, we have a sign-in sheet, and then they sign in there. Then whoever is next goes and picks a test. [We use technology] Everyday, but not everybody - I know if we had more computers, it will be a little better, but I tried to - like for the Hispanic ones, they are using it daily because they need to learn the vocabulary and grammar, the English. Other students get to use it to do research or to - once they have used that - once the Imagine Learning is over, then they can either take a test. Normally, we do take tests when we're doing silent reading in the afternoons. They come and they do have a sign-in sheet, and then they sign their names, and so there is a person that is in charge, who is the manager, computer manager. Then they let them know - okay, they sign and then that person lets them know, "Okay, you're next. You'll take a test." So for other things, I mean, they use it as - the manager kind of monitors that. I mean, I really don't get into that. Unless we're doing a presentation or something that - then I give them a lesson on technology, like how to - but they already - many of them, they're like - they are so good on computers, even better than grown-ups sometimes I feel like - because they do that at home at all times, and so they like that. I mean, the only thing I'm not really teaching is the keyboarding. Some students that are new to computers, they do take a long time. I feel like, "I wish I could have more time and more computers to do

		that," but it's pretty hard to - because the classrooms are so small. There's not enough space. I mean, they have offered me, "Do you want another computer?" I mean, it's like, "Where do I put it?" So it's pretty hard, but we try to do as much as we can.
Kenneth	I believe, and I'm absolutely convinced of this, that technology, the classroom should be a - technology should make the classroom an extension of the teacher's senses and that artificial intelligence should be called into play. All this stuff I'm talking about is already off the shelf stuff. So face recognition, the software knows who it's looking at and can file the things that the child does in a file so that instead of me constantly having to do - public schools demand tons of data. Instead of me doing a lot of data acquisition, the data acquisition is done by the software. So the eyes of the room are watching the children, the ears of the room are listening to the children, and the software that's available, I mean there is software that can decide whether or not someone is behaving like a terrorist in an airport. Now how does it know that? So if you have temperature sensors you can track hotspots in a room if a particular child is hotter than usual, one, you know they're getting a fever. But two, is there something, are they colder because body temperature changes in relationship to your emotions. So the room should be a robot. The classroom should be a robotic environment where the students are constantly being tracked and evaluated. I cannot tell you how frustrated I am that there is software to sell people things, there is software to track stock markets and you can sign on and get on a website and have all this software and all this hardware at work on you. I mean there's more technology in a cell phone which you can point, GPS tracks, stand anywhere, point at a building and it knows where the nearest place is to get an ice cream soda or it'd give you a choice of three. And it's just phenomenal that the education of our future generations is not worthy of that kind of investment. So yes, does technology have a place in the classroom? I am a long-time proponent and I would like to see it start with the two-and-a-half, three-year-olds in early childhood	Interviewer: So I talked to you earlier about what technology you used? Have you added or changed any of that technology since then? Kenneth: No. No, I'm all about technology. Out of the four, three worked and here they are so now I have six student computers and I have - this is my computer plan. They're assigned which computer they use and I'm enforcing it because I want them to do Microsoft Word and PowerPoint and this way - that's not web-based and this way, their stuff will be just on their computer so they can find it. They don't really know that exactly. I've told a couple of them that. I have FASTT Math. Did you know about FASTT Math? I have FASTT Math. I have created - did I tell you about the PowerPoints I created? I've had some websites which are unlinked to the student, and I'm in the process of getting Reading Street on. I sent home a flyer. I got one that was provided for the whole school and I was eager to send it home. It's a Reading Street code. Or no, the whole school didn't get this I don't think. I think very possibly, I just printed the parent letter. Yes, I just printed the parent letter. It's their own site so whatever it is they do, I can see their individual work which is way cooler than some Reading Rabbit disc that takes five minutes to load. I'm getting Right Source turned on which is an online learning - and when I got - which I've done the training online for, Right Source, but there wasn't a way to get it coded in.

	Montessori where it would really be revolutionary. In this class, the amount of paper the children create would necessitate good scanning equipment and software that can evaluate what they scan out, what they do with paper because they have phenomenal skills. So yes, I believe technology belongs in the classroom. Ridiculous that it's not here, it's short-sighted.	
Lance	No pre-interview	Well, I think it should have - I think it should be a piece of what they're doing every day, for sure. I mean these children are growing up with technology at their fingertips and so it's a natural transition for them to start to use the technology for learning ways. It interests them. I've got students that are enjoying making cartoons on a website that they can go to. The upper elementary uses the Glogster accounts where they can go in and basically do - it's kind of like PowerPoint on a webpage, basically, where they can move images. So, they're not doing anything super special necessarily with the technology, but it's just an avenue for them to be getting familiar. It's like take these facts and put them into this new format, and find pictures that go with the information. So, it's just a way for them to process that information besides in the classroom. Well, probably the biggest piece [of technology use] is the research. It has the good connection with Montessori. The Reading Street and the Imagine Learning and all that is really not true Montessori, I guess, but I don't - I'm sorry. You're kind of confused on what the difference is. So, I think it's just - I think it's important, just because it wasn't a part of the Montessori curriculum, but it was developed - I think there's going to be things that come along that have to be folded in somehow to what we're doing. I think we're getting more and more technological in our society with devices and this and that. I mean just - who knows? Somebody may have to be fairly technical just to drive a car or go to the ATM, or whatever.

Nathan	No pre-interview	Resource. I know you said this is research. You can't reverse the teacher normally. How are you going to teach Eduardo? [Laughter] What I'm saying is resource as a resource. You need a teacher to figure out where the kid - if the kid does not know how to read when he comes in and use different things to get them to where they need to be. So technology is good but you kind of as a teacher need to guide them. It would help the students that are independent - maybe fifth grade, sixth grade, higher where they need less the teacher aid and reading and what have you. That's never going to replace the instructor. It's not appropriate when you use it as your curriculum, when you use it as your cure-all, when you use it in a way where the students only use that and they don't use - because I've seen it and it's just horrible. It's horrible. For example, I use Study Island. I use it as a resource but I teach to listen, do hands-on, do questions hands-on, and then I'll put them on the computer for them to practice and then they have to write what have you and then they get it. Then they test it.

2. *How do teachers in a technology-infused lesson study group change their lesson planning and teaching behaviors?*

There was no change in the way that they planned or taught as a direct result of lesson study professional development. However, changes were made to the teachers' planning and teaching behaviors based on the weekly team meeting conversations. First, the team began giving written weekly assessments in reading and math to their third grade students. In addition to these tests, all of the teachers began to hold small group lessons with all of their third grade students. Previously the teachers had met in small groups or individually with students based on their skill level or progress with the Montessori materials, not based solely on their grade level. These new third grade small group sessions focused on the objectives tested on the benchmark test. This was done

because third grade is the first grade level that students in this state have to take the high stakes standardized test.

Kenneth also changed the way that his students tracked their individual student work. In Montessori classes, each child creates a weekly plan with learning goals and specific learning tasks that they will accomplish. This independent work plan is co-created by the teacher and student and serves as the main form of differentiating and tracking instruction for each student. Kenneth created a new format for his students' individual work plan and shared this with his team. His new format set numerical goals for the amount of work that each student needed to accomplish in each subject area daily. Marianne also changed her student work expectations. Instead of giving the students a three-hour work time to complete all of their assignments in the order of their choosing, Marianne divided the three-hour time block forcing all students to complete reading/writing activities in the first ninety minute block and math activities for the next hour. Students were given the flexibility to choose their work focus in the last thirty minutes of the work block. By dividing the time, Marianne was able to better monitor her students' progress in a subject and ensure that all students were dedicating enough time to the core subjects.

The group discussed several suggestions for classroom management, new materials, and teaching strategies (see Table 11). These could have led to other changes in planning or teaching behaviors that were not captured by the data in this study.

Table 11

Team 2: Examples of sharing strategies and materials

Topics	**Examples**
Reviewing Common Assessments	Kenneth: I read the answers so that they can have the experience of marking what's right and wrong. And then I take that child that has a 100 percent and I go, 'Cool. Go back to your work. Who missed one?' And then we take that child. They have 90 percent, so we discuss the one that the missed. I go, 'That's great. Thank you.' And then everybody else sits and we start at question number one. 'Who missed that? Who missed that?', you know? And we go through and we analyze the questions. So I have an immediate discussion. It's formative, so we just have an immediate conference with the third graders. It's very productive and enjoyable for all of us. And they really have bought into the process. They like it. And it's effective, I think. (Team 2: December 16, 2011)
Conducting Read-Alouds	Marianne: Then I do read aloud. Ask a lot of questions. We go over all of them, literary elements, when I'm reading aloud. I ask them 'Who are the characters?', 'What is the setting?', 'What is the theme of this story?' And they're getting good at that. They're really understanding it, the plot, and how was the problem solved. (Team 2: December 16, 2011)
Classroom Management	Nathan: What I'm doing is the students that are working I'm working with them, they're producing, they're working. The students that are goofing off, just constant behavior problems. I've got them seated at a table. Kenneth: Yes, a little separation. Nathan: Separated and then they're working, I'm giving them worksheets. Kenneth: Well the main thing is that they get the idea. I understand what you're saying. Nathan: Because what happens is they're taking over the class. So now I have four students who are working on worksheets. They want to get back in, but I'm telling them that you can't until, because everybody's working. And then we have a meeting and we go over 'Do you want them back? Have they behaved?' Kenneth: Good, a class meeting for it. (Team 2: December 1, 2011)
Reading Materials	Marianne: What are we going use to teach it? I'm using this (Holds up a reading resource material) and I've had it for a couple of days and I wanted to share it with you. This is "Critical Reading" and you've probably seen it before. There's different booklets. And we've starting working on this one (main idea) and this one (context clues) with only the third graders. And they're really good. I mean they're really good. They have main idea and theme. It's to learn about all of these different concepts, you know, that you teach them. And we're using the projector and we're doing it, giving examples of things in order to actually teach. Because if we just give them the tests and we don't teach it, then they're not going to score anything. (Team 2: December 8, 2011)

3. *Were there features of the group (such as membership, grade level, subject matter, group interactions, etc.) that played a role in the teachers' development?*

Despite Team 2's eagerness, this group was unable to get past the first step in the lesson study process. Lack of leadership, time constraints, lack of comfort with the Montessori curriculum and competing responsibilities all contributed to this team's lack of progress.

Neither Marianne, the team leader, nor the principal pushed for progress of lesson study professional development in this team. Kenneth was excited about the cycle, and brought it up in the meeting on December 1, 2011, but with only two weeks left in the semester it was too late by that point to begin. At the beginning of the nine weeks, the team meetings were informal, with none of the teachers taking a clear leadership role. For example, team members came late to the meetings and the teachers tended to discuss personal issues and complain about all of the things that they need to get done. Before I joined the team meetings, Lance described the weekly group meetings as a "teacher support group" but he mentioned that the lesson study professional development and then the pressures of the benchmark created an agenda for the team. He stated that this did add a new element of pressure and that having me record the meetings changed the tone of the conversation. As quoted in his teacher profile, Lance felt having an outsider join the group altered the way that he and the other group members spoke during the meeting. Additionally, he found the deadlines and responsibilities of the lesson study professional development overwhelming.

On the other hand, Nathan felt that these first semester meetings were a waste of time and longed for someone to step up and lead the team. He felt that his team could be

very successful if they had a stronger leader. As the former assistant principal, Nathan deliberately took a passive role in the meetings. In the following quote Nathan describes his thoughts on the weekly team meeting and his role in them:

> This year, we haven't had very many that I think that you can say they've been connected. Maybe the last one. I think it has to be more focus on like: Where we're at? Who's learning? Who's not learning? Bring your kids. Who work together? Can you work with this kid? Do you think you can work with-? I don't see that. I don't want to take over the meetings. You know what I'm saying? I'm trying to be the one low key, the one in second or third tier. I'm trying to do that because I know how to focus on what I have to do here and make it right, but I don't see that. For example, in the true leadership capacity in our [team meeting] and I'm hoping we get to that point and then I think they would be more like super team. I don't want to be a boss saying, "Hey, maybe you guys, you need to be-" I want them to try to come up with it. I'll try to push it but I think it has to come from the team members. You know what I'm trying to say? I don't want to say, "Hey do it this way!" and they end updating me or they won't work with me or they just totally ignore me. What I'm hoping is slowly get in there and - I wish it was different but knowing personalities and everything else, you really have to work in that way. Otherwise, you get the team to hate each other and nothing ever occurs. (Interview)

After the benchmark test results, the principal became the clear leader in team meetings. She had an agenda and dominated the conversations. In meetings where she was late or absent, Nathan finally started to take more of a leadership role. He created the reading and math common assessments for the team and called for his teammates to help him create the assessment in the future. He even trained Kenneth to use the test-construction software. Although he called for more cooperation in making the assignment and planning complementary lesson plans, this did not manifest in the team because no one volunteered or assigned roles.

Time constraints were another factor in the team's lesson study progress. Both Marianne and Lance were concerned about the time commitment in the interviews and during the initial meetings about the lesson study professional development.

> Lance: I think it was just - even though it seemed simple, we're just so at the edge to add anything else. It just feels kind of overwhelming. (Interview)
>
> Marianne: Time. I mean, time. Honestly, I feel like I want to do it, but it's just so much going on right now that it's never enough time. I am pretty sure everybody is the same way. It's just so many requirements, these and that, and they ask you to do these and these - I mean, there's just never enough time. I mean, right now, it's even worse because we had the Thanksgiving's break, and then now it's the Christmas break coming, and it's like, "Goodness." There's too much going on, too much. The holiday program that

> they have to do a rehearsal, I mean, it's like, "Oh, my god." It's just never enough time. (Interview)

They complained that with all of the other required professional development, school functions, and regular classroom tasks, they did not have time for such an involved professional development. This team was already concerned that the requirements of public school education were cutting into the time they needed to the implement Montessori curriculum with fidelity. The team discussed having extra weekly meetings to complete the lesson study process, but was not able to find a common time when at least one of the teachers did not have professional development, a parent conference, or student tutoring. Finally, this group had only one semester to complete the lesson study cycle. This semester include Thanksgiving break, a benchmark test, and at least two school programs (Junior Achievement guest teaching and a Winter Program). All of these events took instructional and planning time away from the teachers.

A third factor affecting this group was the lack of confidence with their skill in using Montessori curriculum. Three of the teachers were new to an early elementary Montessori classroom. In addition to this new curriculum, the teachers were expected to produce good test scores on the standardized tests. The principal even pushed these Montessori teachers to be an example for other schools. This was a lot of pressure for a new teacher. Lance described this pressure in his interview:

> Well, last year I was in a second grade traditional classroom, so I had - we got our routine over the first few months of school. We got our routines down and we got our Reading Street program. We had our Envision Math

> program and we had a science textbook, and we had a Social Studies textbook, and we had a Spelling workbook, and we had books and things for everybody in the classroom because they were all second graders and they all got second grade materials, and we have a schedule and we follow it. To have three different grade levels in here and to have all this focus on this new big [standardized] test for my third graders and all these other programs going on, it's - and then for me, and like several other people here going through their internship year in Montessori where you're really trying to follow exactly what we just came out of and trained, but kind of having these different camps pulling and pushing with what's important and what are we doing, on one hand, which is to have our objectives posted in the room, but on the Montessori side, to waste time on things like that would be ludicrous. I mean you would spend every second in the classroom during your work time giving lessons and helping students, and there's just not a lot of strong correlation between the two programs and in the past, we kind of - as a program within the school, we had a certain amount of just - we were cloaked a little bit. (Interview)

After trying to balance the Montessori curriculum and district testing, asking these teachers to integrate technology was too much for them to juggle.

Traditional Upper Elementary Team (Team 3)

The traditional upper elementary team (see Table 12) consisted of four classroom teachers: Gabriella, Irene, Hannah, and Joseph. (Joseph did not consent and is not

included in this analysis.) In terms of collective experience, this was the youngest team at Openwood Elementary School. They were also the most technology rich team on the campus. Irene had a full class set of computers with Internet access for a fifth grade math program. Hannah was given one of the two Smart Boards on campus to use in her classroom. The other Smart Board was in the school computer lab. Even Gabriella, who started out with only two working computers, was given more computers and licenses to a remedial reading program for all of her students when she became a self-contained teacher. Additionally, she negotiated with the computer teacher for extra time in the lab.

Table 12

Traditional upper elementary teachers

	Irene	**Hannah**	**Gabriella**
Grade Taught	4th/5th	4th/5th	4th/5th
Years Experience			
Veteran (15+)			
Mid-Career (6-15)			*(12)
Novice (0-5)	*(3)	*(3)	
Available Classroom Computers (#)	5	5	20+
Reported Classroom Technology Use			
Tape/CD player			X[1]
Projector/ Elmo		X	X
Educational Software	X		X
Educational Website			X
Computers for Research			
Microsoft Word			
Microsoft Power Point		X	
Blogs			
Assessment Software			
Smart Board		X	

[1] X means that the teachers reported using this type of technology in their classrooms.

The following section gives a description of Irene, Hannah, and Gabriella. These profiles were constructed using information from interviews and class observations.

Traditional Upper Elementary Team

The four teachers in this team taught fourth and fifth graders. At the beginning of the school year, the team was departmentalized. Each teacher taught one of the subjects and the students rotated through all four teachers. There were two classes of fourth graders and two classes of fifth graders. After the benchmark testing, the team decided that some of the fourth grade students needed extra support in reading. To meet the needs of these students, one teacher, Gabriella, became a self-contained fourth grade teacher. She taught these struggling students. Hannah, originally the writing teacher, began teaching both reading and writing to the rest of the fourth and fifth grade students.

Irene. Irene was the team leader and the math lead teacher for the campus. In her first year teaching, Irene taught English and math to a bilingual second/third split class. The second year she moved to a fourth grade math, science, and social studies position. The year of this study, she was teaching fourth and fifth grade math.

Although she was only a third year teacher she was involved in a leadership program through the district. She said that she sought out this professional development opportunity because she would "really like to move up and be an administrator or an instructional coach at some point, so that really helped and allowed me to see kind of what else is out there in education apart from a classroom teacher" (Post interview). Irene was a former Teach for America corps member and had worked as a TFA Corps Member Advisor the previous summer.

In her role as a teacher, Irene felt that she needed to be a strong role model for her students. She stated:

I guess as a teacher, you wear multiple hats. Not only is your primary focus obviously to educate the students and get them up to their grade level if they are behind, but you also - there's a whole separate part to teaching as well where you're, I guess, installing a sense of level of learning and a sense of responsibility and a sense of self, I guess, just trying to make them see kind of that more qualitative data where like they see themselves going to college or pursuing something beyond what they initially imagine coming into my class. I guess you're a prime motivator, a prime influencer and a prime - just role model in a sense trying, not only to educate them on their academics, but just kind of make - grow them into good people is something that I've been able to know after the first and second year of teaching. I've been able to now focus on since I have a little bit more understanding of where I want to be. (Pre Interview)

Later in her post interview, Irene reiterated this viewpoint saying:

I think first and foremost, you are obviously there to make sure that you're targeting the academic side, like what they're supposed to learn in your grade level, and if that means remediation, that means remediation. I think another important part that maybe isn't talked about as much just like being a role model and being an instructional leader in the sense of teaching the students those - more ethical and just the less concrete objectives, like just how to be a respectful person, citizenship, I guess in a

sense and trying to kind of install a sense of self-motivation so that they can really succeed as much as they possibly can. (Post Interview)

When asked about her role as a teacher, Irene focused more on the motivation of the child than the academic achievement. However, in observations Irene used student data and academic progress to instill a sense of motivation in her students. She had class achievement goals written on the board and graphs tracking the students' progress on the walls. During two different observations, Irene referred to the goals and reminded the students of an upcoming assessment. She asked the class what actions they needed to take in order to meet their class goals and allowed the students to offer suggestions such as studying their multiplication facts and practicing more word problems.

In regards to technology, Irene was in the only classroom with a one-to-one laptop-to-student ratio. Her classroom was also equipped so that all of the laptops had Internet access. She used a math curriculum that required her fifth grade students to be on the computer for the majority of the class period. The program taught, tested, and re-taught math objectives on an individual basis. The program also allowed Irene to instantly access information about her students' progress. She used the data to decide when to teach small group lessons and whole class mini-lessons. Irene's fourth grade students also used the math software, but only as supplemental instruction. Because of her use of this math program, Irene felt that technology was very important for differentiating student learning. She describes this sentiment in the following quote.

I think it is really something that we haven't tapped into the potential, like not that I'm super experienced in education, but just seeing like what I can

do with my fifth grade curriculum. This is my first year doing it as the focal point where the students are on the computer for pretty much my whole period. It's just amazing the power to differentiate because I know ever since coming in to teaching, there has been this huge push for differentiation, which obviously make sense. You want to make sure that you're meeting the needs of every student, but at the same time, being one individual and trying to differentiate for - I mean, in a departmentalized world, 60 to 90 kids can be very challenging.

Where technology I think does a lot of that groundwork for you. Then also when it comes to [data] issue, which is something that I really support and think is an important tool for instruction, it's just instant feedback. I can - with my programs specifically; I can go and pull up the problems that they worked on that day. At the end of the period, if I have any extra time, I pull up their accuracy and that student that struggled I can literally go and see what they've been doing this whole time and like pull them aside and work on the problems with them.

That's just not something that you can necessarily do in a classroom that doesn't have that sort of technology. It just takes time to gather that data. I think that we just really is something that we haven't tapped into enough and is going to be a focal point in the future, I would hope, just because it does provide so much opportunity for better instruction in a sense. (Pre-interview)

Irene liked the technology's ability to target her students' learning, but struggled with the idea of her students spending most of her class in front of a computer screen. She stated that, "I think it's a fair argument to say that you want the students interacting with each other, which is I know something that I really had to reflect about going into this year with my fifth graders being on the computer all the time. I think it's important school should be developing social skills as well" (Pre-interview). Irene's feeling toward technology remained the same in the post interview as evident in the following quote.

> I think [technology is] super important, especially with being able - this is my first time using [online math software] as the core curriculum. I used it last year in my fourth grade class as a supplemental and just seeing that - I think differentiation is hard for any teacher, no matter how many years you have of teaching, like you're always going to have a different class with different needs. So when it comes to differentiating like what you do one year isn't necessarily going to work the next year, but technology really opens that door to do a lot of the prep work for you. (Post interview)

She also commented on the importance of balancing the social aspect of learning in her post interview.

Because of her leadership positions, Irene reported attending lots of different professional development trainings. She felt that timing was a big factor in the effectiveness of professional development, and said that she "got a lot of what I needed at

the right time" (Post Interview). Like Hannah, she referred to her summer job with Teach for America as a valuable learning experience:

> I think going back to my summer experience, being able to watch new teachers and just like you see some things that you might be doing, too, that you don't realize and you're like, "Oh, I should probably fix that." You also get to see some great things because they're bringing just this new fresh idea to the profession. I mean, they don't really have - we don't have any background, so they're going with what they think might work and sometimes it does and you really get great ideas from them, too, because they're bringing something new like they don't any better, so let's try it.(Post Interview)

When we discussed how she learned as a teacher, Irene mentioned that self-reflection prompted her changes:

> I think reflecting and coming in - this is my third year, I really wanted to step it up a level. I didn't want to become complacent. I think working and helping mentor new teachers really helped to reinvigorate me. I think just always self-reflecting is something that I've done since the get-go, which is part of the training I had coming in. I just felt that that was kind of pushed aside because of everything. I mean, as a teacher, it just gets crazy, but really seeing how impactful that can be and seeing it work. (Post interview)

She admitted that while she did a lot of self-reflection both globally on her teaching methods and on individual lessons, she had not done any group reflecting on a specific lesson, like lesson study professional develop calls teachers to do. She felt that lesson study professional development would be beneficial, but did not know when her team would have time to fit it into their other responsibilities.

Hannah. Hannah was a third year teacher, and taught at Openwood Elementary for her entire teaching career. She obtained her alternative teaching certification through the Teach for America Program. Much of her professional development was through this organization, and she even worked as a new teacher trainer during their summer institute.

Hannah previously taught reading, language arts, and social studies to fifth grade students, and taught writing to both fourth and fifth grade students this year. She was especially concerned about her fourth grade writing lessons because it was a high-stakes testing subject. She worried that her English-language learners were very low in English reading and writing. When Gabriella became a self-contained 4th grade teacher, Hannah took over the reading instruction for the other three 4th and 5th grade classes. This meant that she was responsible for the students' scores on two high-stakes tests. Hannah was very willing to having me observe her class, and asked for feedback after every session. In her training program, she had been observed frequently with follow-up feedback. During the study I refrained from offering feedback, but after the post-interview, I did provide Hannah with some feedback and writing materials.

Hannah described her lessons using the Madeline Hunter (1967) lesson cycle, starting first with direct instruction and modeling, followed by guided practice, and

finally independent practice. She mentioned the importance of modeling several times in both her pre- and post- interviews. While Hannah wanted to be a "facilitator", she felt that she had to take a more directed approach to teaching her struggling students. In her pre-interview, she stated:

> In my lower classes, it's much more like holding your hand and making sure you're doing it right, like, 'I'm showing you. Now, we're doing it together and explain to me why this is working.' It's a lot slower because in the higher classes, a lot of these steps just come naturally, but in the lower classes, they don't understand like how to make connections. So you're constantly making those connections very obvious to them, whereas in a higher class, they'll make those connections a lot on their own. You just need to question to make sure those connections are actually helping them understand.

She described an ideal student as one that "always wants to push themselves forward" (Pre-interview).

Hannah's use and discussion of technology was consistent with her beliefs about teaching a lesson. Hannah felt that technology should, "help facilitate practice, and maybe help with modeling" (Pre-interview). She used the Elmo projector daily as a presentation tool. Using the Elmo projector, she could read books with her class, correct grammatical errors in sentences, and model writing techniques. She felt that this was the most important piece of technology in her classroom. Hannah also wished that she had more computers with a grammar software program. She talked about the math program

used in Irene's class and wished that she had a "drill and kill" grammar program so that her students could practice their grammar rules more efficiently.

In addition to her computers, Hannah had the only Smart Board on campus that was not in the computer lab. She had recently acquired it when we had the pre-interview. At that time, she was only using the Smart Board to project daily work and work editing sentences. Previously, she used the Elmo projector to perform these same techniques. She was aware that the Smart Board had more advanced capabilities, but did not know how to use them. Later in the semester, she was observed still using the Smart Board as projector. In her final interview, she admitted that she still had not had time to learn to use the full capabilities of the smart board. She mentioned in the post interview that her students used the computers for the same remedial reading program and reading tests that Gabriella used.

When asked about professional development, Hannah focused mainly on her Teach for America trainings. She appreciated training that allowed her to view other teachers in action. She described her favorite professional development in the following quote:

> I really learn by watching other teachers. My favorite professional development, I guess I forgot about this, was when I was a first year teacher and I got to go observe other schools, I absolutely loved that. I love watching other teachers and like seeing what they can do. I love videos of other teachers like those uncommon school videos, I love those. I learn a lot more from those than I do from like just talking about the

ideas because you can talk about anything and make it sound like it's the best idea in the entire world. Then you get back to your class and you try it out and like it just doesn't work but watching it in action and like seeing how the kids react to things like - I think that's the most useful. Also like in a professional development you just focus on one thing but like you do, if you go to observe a teacher when you see a billion things that you want to do. Like I know when I observed another teacher and she was like phenomenal. She was fantastic. I just wrote down like a billion things that I wanted to change about my classroom, but I'd never even thought it. It was much more practical than what you usually get in professional development because then you're like in the theory stage and - I don't know, it's just like the kids, we don't stay - like we go from concrete to abstract. So just seeing like what - exactly how it works is like super, super helpful. (Post interview)

She later described her experiences as a Corps Member Advisor (CMA) in a similar way:

I think the best professional development I received is the summer at Institute when I was a CMA, and teaching other teachers how to be teachers. That really would be - things that like what is a good teacher and then like seeing the mistakes that my corps members made and correcting them really made me reflect on my own craft, and what I could be doing better. And like, the things that I was telling them like you should be doing this. 'Oh, I should also be doing that.' So basically teaching other

> people, like this is what a good teacher does, really helps me define in way I never had before, like, how I would like to be as a teacher and what I think a good teacher is. (Post Interview)

In her interviews, observations, and in casual conversations, it was evident that Hannah was continually trying to improve as a teacher. She felt that using student data and peer feedback were both important for her success as a teacher.

Although her group did not complete the Lesson Study Professional Development, Hannah thought that it could be helpful with some minor changes. She suggested expanding the teacher groups to include teachers from different schools. She argued that:

> It would be better if it was someone from a different school because that would provide a new perspective that maybe you haven't thought about and then there's not the awkwardness of like if you go in and you observe the lesson and it's terrible; you don't see that person every single day and know that they think like, 'Oh well I think that that's not a good teacher'. (Post interview)

Interestingly, this inclusion of outsiders is a common practice in lesson study in Japan.

Hannah felt that the changes to her group, the pressures of testing, and scheduling issues prevented her team from completing the lesson study. She discussed the pressures that both she and Gabriella were facing in the following quote:

> Now that [Gabriella] and I have different breaks, I just think we have been so focused on like…Oh, my gosh, like I've been focused on I have two

> new subjects. I have this new READ 180 [computer program] that I need to figure out that's completely new to me, but then I'll have to use and that's all of my instructions for that class. It's pretty elaborate, and like I didn't get all my materials at first and I'm still setting up - actually I just finished today except one thing. I have one thing that I have left to do with the stupid bookshelf, but I know that [Gabriella] is all focused on what she's doing as well. Like, that's a huge change for her. She picked up way more than three subjects, and now she's self-contained. She has, like, the lowest of the low, and half of her kids like are reading on a kinder to first grade level, and it's just like a lot of stress and other things. So I guess it just wasn't the first thing on our list of things to do. (Post Interview)

Due to all of things reasons, Hannah said that she would hypothetically participate in lesson study professional development in the future, but she did not know how it would be able to work given the current situation.

Gabriella. Gabriella was in her first year at Openwood Elementary School. She and I had worked at the same school three years prior to this study, but had not had any contact since that time. While working at the same school, we had attended whole school meetings together, but did not teach the same grade level and rarely spoke to one another. This previous relationship may have affected her willingness to consent to the study.

Gabriella began the year as the reading teacher for the fourth and fifth grade students, but became a fourth grade self-contained teacher after the benchmark tests. She

did not like the four teacher rotation, because she felt that the students were not getting enough reading instruction. Additionally, she was being asked by the school principal to use small group literature circles. She stated that she was most comfortable with whole class instruction and felt that with struggling readers, small groups were ineffective. She wanted to be able to work with the student directly, and felt that in homogenous groups of struggling students there would not be anyone who could push the group if they got stuck.

In her previous school, she used a combination of whole class direct instruction and computer programs to teach her students. In the past, these techniques produced high standardized test scores for her students. She was frustrated by the changes she was being asked to make and the lack of technology available to her at Openwood. At the beginning of the year, she only had two working computers in her room and these computers did not have the software programs she had used in the past. At her previous school, her students used several reading and math software programs regularly. She had computers in her classroom and her class frequently went to the school computer lab to work. Most of these were drill and practice programs that tracked the students' progress. She also used a reading program to motivate the students to read more books. The students received points for every test they took. These points accumulated to earn prizes.

Gabriella's reliance on technology started two or three years earlier when she lost her voice due to vocal cord strain. Gabriella stated initially she had been opposed to technology, but she was forced to change her techniques in order to protect her voice.

Her previous school was technology rich and had a dedicated computer support person. This support person did the technical tasks of fixing on campus computer problems, but also spent a good deal of time helping teachers incorporate technology. After seeing her students' test scores improve, Gabriella was convinced that technology was essential to her students' success.

Gabriella consented to class observations, but only if they were pre-planned visits. When I actually tried to schedule the visits, she was reluctant to schedule times for me to observe. In the post interview she mentioned that she "did not like to have people in [her] classroom." After Gabriella was assigned to the self-contained classroom, she became more open to my observations. On one occasion, she even let me observe without prior notice.

The self-contained classroom allowed Gabriella to go back to her previous way of teaching. In the classes I observed, she was using the projector to conduct a whole class reading lesson. In addition to the whole group lessons, she was given a new reading program to use with her students. The program was a remedial reading program. She had not used the program in the past, but it allowed her to manage small groups in her class more easily. Additionally, Gabriella worked with the computer teacher to gain access to the computer lab. There was usually an ancillary class in the lab, but Gabriella took her students during the computer teacher's planning period. During this time Gabriella used a computer program that read books aloud to the students. She stopped the book frequently to ask comprehension questions. At the end of the story, the students

took an online reading quiz over the story. After the change in her class, her demeanor was happier and confident.

Gabriella was the newest member of her team and did not always agree with the other teachers on the team. In the meeting I observed, there were no direct arguments, but you could tell that she was not as comfortable with the other members of the group. In informal conversations, she mentioned that she was not adjusting well to working closely with her team or the departmentalized model.

Joseph. No profile is constructed for the fourth teacher because he did not consent to the study. His comments and participation were excluded in analysis of the team's lesson study professional development.

Lesson Study Professional Development

This team was initially chosen by the principal to start lesson study in the first nine weeks of the school year. She felt that with their technology skills, they would be the most open to a technology integration professional development. However, the collaborative planning of lesson study was challenging for the teachers who were all teaching different subjects. The team and I decided that they should shift their start of the lesson study professional development to the second nine weeks of the school year. They still had their regular weekly team meetings starting the first week of school.

At the beginning of the second nine weeks, I met with the teachers to discuss the lesson study process. They were still teaching different subjects and decided to create model lessons in pairs: Gabriella and Hannah creating a reading or writing lesson, and Irene and Joseph creating a math or science lesson. Because of the departmentalization,

they would each re-teach their own lessons with a second class of students after completing the initial reflections. The team seemed willing to participate, but also mentioned that they were already doing a lot in their group meetings to help their students.

Irene was the leader of the team, but she and Hannah worked very closely together. They had started teaching together through the Teach for America program. This alternative certification program provided them with training during their first two years of teaching. Since most of their teacher training was the same, they had very similar philosophies about teaching and even teaching strategies. This closeness made Gabriella the outsider in the group. Rather than meet during the school day, this team chose to meet afterschool at a local restaurant and bar. Despite the unconventional location, this team's meetings were productive and focused on student issues. Irene described them in this way:

> Okay, I think our PLC meetings have certainly evolved over time. A lot of it at the beginning, we were just trying to norm on our expectations as a team. 'What are the things that we want to see across classrooms? What expectations do we have of students?' Just kind of getting out those logistical things, and now what it has really turned into is we kind of talk just about where our students are academically. Recently, after having benchmarks, we've talked about those students that are really struggling across the board and speaking of what's - talking about what sort of interventions that we need to do because they're clearly - they need more

than what we're helping them with now... We're really focused on interventions for our students that are struggling academically or behaviorally. Then the next meeting, we obviously check upon those before we get into the new conversations. (Post Interview)

The after school meeting time also allowed the teachers to meet for longer than the allotted fifty minutes. Because this team met off campus and did not discuss the lesson study professional development in these meetings, I only attended one group meeting. Through informal conversations with Irene and Hannah, I learned that the team was not making any progress on lesson study. Even in the two hour meeting that I attended, the teachers did not mention lesson study professional development at all. Instead, they talked about individual student issues and collaborated about ways to regroup the students, provide tutoring for struggling students, and ways to improve their classroom management plans.

Research Questions

1. *How do teachers in a technology-infused lesson study group develop (a) their attitudes toward technology and (b) their technological pedagogical content knowledge (TPACK)?*

This team never engaged in lesson study professional development, so there were no changes in their attitudes toward technology or TPACK. Pre and post interview quotes of their technology beliefs are shown in Table 13.

Table 13

Team 3: Technology beliefs pre- and post lesson study professional development.

	Comments About the Role of Technology in Schools	
Teacher	**Pre-Interview**	**Post interview**
Irene	I think [technology] is really something that we haven't tapped into the potential, like not that I'm super experienced in education, but just seeing like what I can do with my fifth grade curriculum. This is my first year doing it as the focal point where the students are on the computer for pretty much my whole period. It's just amazing the power to differentiate because I know ever since coming in to teaching, there has been this huge push for differentiation, which obviously make sense. You want to make sure that you're meeting the needs of every student, but at the same time, being one individual and trying to differentiate for - I mean, in a departmentalized world, 60 to 90 kids can be very challenging. Where technology I think does a lot of that groundwork for you. Then also when it comes to [data] issue, which is something that I really support and think is an important tool for instruction, it's just instant feedback. I can - with my programs specifically; I can go and pull up the problems that they worked on that day. At the end of the period, if I have any extra time, I pull up their accuracy and that student that struggled I can literally go and see what they've been doing this whole time and like pull them aside and work on the problems with them. That's just not something that you can necessarily do in a classroom that doesn't have that sort of technology. It just takes time to gather that data. I think that we just really is something that we haven't tapped into enough and is going to be a focal point in the future, I would hope, just because it does provide so much opportunity for better instruction in a sense.	I think [technology] is super important especially with being able - this is my first time using Reasoning Minds as the core curriculum. I used it last year in my fourth grade class as a supplemental and just seeing that - I think differentiation is hard for any year - how many years you have of teaching, like you're always going to have a different class with different needs. So when it comes to differentiating like what you do one year isn't necessarily going to work the next year, but technology really opens that door to do a lot of the prep work for you. Reasoning Minds is a prime example for me because it's essentially for students struggling with something. It will automatically send them back to remedial objectives. Whereas as a teacher, even if you know they're struggling coming in, that's something that you have to plan for and you have to pool in stuff, but technology just does that. It does it in real time. I don't have to wait to give them a test. They're seeing - they're struggling with this and they can bump them backwards. If you see a student struggling and even if you're working in a differentiated learning centers, you still are going to have to either sacrifice the students that you're working with and go back to teach just one student or you're going to have to address it a different time. Whereas technology allows me to avoid that completely, and I think it's important, too, that our students know how to use technology because that's where the world is moving. Everything is becoming digital, and if they want to be competitive, they have to know how to use those tools.

Hannah	I think technology should help facilitate practice, I think, and maybe help with modeling. Like any kind of technology like the Elmo? I mean, it's super helpful when you're modeling, so all the kids can see what you're writing on the Elmo. I like that, and then I would love - like I know [Irene] has the computer program where they practice in there, like what they do is track, but there's nothing lined up for grammar. I would love something like that for grammar because then - I mean, it's just drill and kill, like you explain it and then you practice it over and over and over again, and I feel like there's not enough of that. It's harder to do it in worksheet form, one, because our copies are limited, so I can only make so many. Two, because - I don't know, it's just time-consuming and that's not what you really want to be focused on. You want to put their time on reading their actual longer pieces instead of like, "Oh, [let's create] this worksheet." So I would love that for technology, but it's also really nice for research for the kids to go on the computer and look up different things that they're interested in and then change that into a report.	I think technology should help facilitate learning. I think it's the most useful in the independent practice section. For kids, I think like the modeling and the guided practice, obviously you need the teacher for both of those but for the independent practice, I think that's great for kids and kids are super excited [to have that with] the computer. Also technology like the ELMO is just great for modeling, for everyone to see what you're doing and it's easier than writing on the board.
Gabriella	Very, very important. Here we don't have a technology lab where we can just go and sign up and then everyone go save your place in the lab. If you remember, at [the school we worked at previously] we had a lab where we could just go. Technology is super, super important. There are programs that would really, really supplement your curriculum, that could do it very well.	I was kind of stubborn with [learning] the technology. I didn't want it and then it turns out it's like I can't live without it now.

2. *How do teachers in a technology-infused lesson study group change their lesson planning and teaching behaviors?*

This team never engaged in lesson study professional development, so there were no changes in their planning or teaching behaviors due to this professional development.

3. *Were there features of the group (such as membership, grade level, subject matter, group interactions, etc.) that played a role in the teachers' development?*

Three group factors contributed to this team's failure to complete lesson study professional development. The first obstacle for the team was trying to manage a

collaborative lesson planning task when all of the teachers were teaching different subjects. With my guidance, the team ultimately decided to work in pairs to create the lessons, but even this was not ideal and did not lead to any progress in the lesson study professional development.

A second factor in the failure of lesson study was the pre-established group norms. This team was committed to collaborating about student learning issues and had established a routine in their meetings before lesson study professional development was introduced. At the meeting I observed, there was a clear agenda, but it did not include lesson study. The team members were willing to stay late to discuss the typical topics, but did not make lesson study a priority during this meeting time. Irene's interview comment in description of the lesson study professional development illustrated this pre-established routine. Hannah even discussed the teacher's chosen meeting time and location as an essential part of their routine:

> It's much more relaxed when we meet off campus. I mean we all love to talk about our kids and I feel like it's more kids-centered when we're off campus for some reason. I think on campus we just have the mentality like I have all these things to do. (Post Interview)

This team purposefully left campus to escape from the extra things that overwhelmed them. Although not blatantly stated, lesson study professional development may have been perceived as one of the many things that distracted them from keeping a student-centered focus even though the intent of lesson study professional development is to highlight the students and their learning.

The final factor in this team's professional development was the constant changes in scheduling and student groups. Hannah discussed this issue in her interview:

> Well, first of all, I think we didn't get started just because we have all the same breaks but now that [Gabriella] and I have different breaks, I just think we have been so focused on like - oh, my gosh - like I've been focused on I have two new subjects. I have this new READ 180 that I need to figure out that's completely new to me but then I'll have to use and that's all of my instructions for that class. It's pretty elaborate and like I didn't get all my materials at first and I'm still setting up - actually I just finished today except for one. I have one thing that I have left to do with the stupid bookshelf, but I know that [Gabriella] is all focused on what she's doing as well like that's a huge change for her. She picked up way more than three subjects and now she's self-contained. She has like the lowest of the low and half of her kids like are reading on a kinder to first grade level and it's just like a lot of stress and other things. So I guess it just wasn't the first thing on our list of things to do. (Post Interview)

In the first semester, the teachers worked to strategically regroup their students based on learning objectives and behavior issues. They had finally established a routine when they received a computer-based remedial reading program. The introduction of this program meant that they had to re-group their students again. A third change to the schedule and class structure came about after the benchmark test scores were released.

These changes forced lesson study professional development even further down the priority list.

Cross Case Analysis

Looking across the three team cases, several themes emerged. These themes deal with the factors that either facilitated or stifled the team's progress with lesson study professional development. Table 14 shows some of the team characteristics and the teams' lesson study progress. These factors also influenced how the teachers' attitudes, beliefs, and behaviors regarding technology changed over the course of the semester.

Table 14

Teacher team characteristics

	Team 1	**Team 2**	**Team 3**
Leadership	Strong leadership, supportive of completing LSPD	Weak leadership	Strong leadership, not supportive of completing LSPD
Overlap of Teaching Content	Overlapping grades and subjects	Same grades and subjects	Same grades, different subjects
Time frame	1st & 2nd nine weeks	2nd nine weeks	2nd nine weeks
Competing Changes & Responsibilities	• New grade levels • New science curriculum • New writing curriculum • Testing pressures (2nd nine wks.)	• New grade levels • New science curriculum • New writing curriculum • New Montessori teachers • Testing pressures	• New grade levels • New subjects • New science curriculum • New writing curriculum • New reading curriculum • Testing pressures • Scheduling / student changes
Conversation Style	Direct, Purposeful, Rushed	Collaborative, Unfocused	Purposeful, Data-driven
LSPD Progress	Scripted lesson, observed lesson, partial group revisions, re-taught lesson	Several attempts to choose a lesson, collaborative discussion, but not action	No attempts to start LSPD

Success of Lesson Study Professional Development

Three overarching factors contributed to the groups' (non)progress in lesson study professional development:

- presence of a lesson study professional development advocate within the team
- number of other school-based changes the team members were facing
- the time frame for lesson study professional development

Advocates. Both early elementary teacher teams, Teams 1 and 2, had an advocate of lesson study. On the traditional team (Team 1), Deborah was the advocate, continually checking on the team's progress. As the team leader, she ensured that the team made time to discuss the lesson study professional development in their meetings. Deborah tended to focus on accomplishing each step quickly in order to complete the process. She wanted to finish the lesson study so that it was "off their plate." As mentioned in her team's case study, she was also more interested in helping complete the study requirements for me than actually participating in or trying to learn from the lesson study professional development. This leadership style kept the process moving, but it did not always allow for discussion and collaboration. It was more about checking off the tasks quickly and efficiently.

On the early elementary Montessori team (Team 2), Kenneth was the strongest advocate of lesson study. He was the most excited about the lesson study process and brought it up most frequently in meetings. Unlike Deborah, Kenneth was not the team leader and was unable to make lesson study professional development a priority for his team. The team generally acknowledged that they needed to discuss the lesson study

professional development, but quickly moved on to different task or topic. When the group did discuss lesson study, they had good brainstorming discussions, but without a stronger advocate the team was unable to implement their ideas.

There was no advocate for lesson study professional development in the upper elementary team (Team 3). Besides the first meeting, when I introduced the lesson study process, it was not discussed in their team meetings.

For all of the groups, the school principal was a pseudo-advocate. In initial preparations before the school year began, she was excited about lesson study professional development. She felt that it would help all of the teachers at her school and agreed to require the process as part of the teachers' professional development requirement. She even added the technology-infused lesson study professional development on the school's growth plan as a way to increase technology integration on the campus. However, in practice she did not enforce this requirement. While she supported me in telling the teachers it was required, she did not talk to the teachers directly about the importance of lesson study professional development. In one instance, a team complained to the principal about not having enough time to do the lesson study professional development and questioned it being a required professional development. Rather than state the importance of the lesson study professional development, the principal referred the team back to me (Field notes: August 18, 2011). Ultimately, this team refused to participate in the lesson study professional development at all. Additionally, the principal did not allow any time for the completion of the lesson study professional development in team meetings after the low benchmark test scores. At this

time, she assumed the role of leader for all of the team meetings and never included lesson study professional development on the agenda.

Looking across the three groups at Openwood, it seems that the combination of a strong team leader and principal, who are both supportive of lesson study professional development, are needed in order to push a teacher team forward in the process. Without strong leadership, teachers on the team may be strong advocates of the lesson study professional development, but not have the social or political capital to push the lesson study professional development forward with their team.

Competing responsibilities and changes. Technology integration was not the only school initiative at Openwood during the 2011-2012 school year. All of the teacher groups at this school were dealing with a new standardized test and new curriculum materials. Additionally many of the teachers were teaching new grade levels or under a new Montessori paradigm. These competing responsibilities and changes affected each team's ability to complete the lesson study process. The team facing the fewest changes in their teaching practices (Team 1) was the one who was able to devote the most time to lesson study professional development.

The traditional upper elementary team (Team 3) was the least experienced teacher group. In addition to their inexperience, the most experienced teacher on the team was new to the school. Each of these teachers was adjusting to teaching and planning for two grade levels and working in a departmentalized team of four teachers. Irene was learning how to use a completely online math curriculum with her fifth grade students. Gabriella was trying to use literature circles to supplement her whole class instruction. Hannah

was adjusting to teaching writing for the new state standardized test. Just as this team started to settle into their new positions, the benchmark test scores caused them to redistribute their students into one self-contained fourth grade class and three departmentalized classes. In post interviews, these teachers remarked that these changes were not only affecting the teachers, but also affecting the students' motivation and performance. Hannah described these changes as "growing pains":

> I think because we had a lot of issues with growth - like first of all, norming as a team and then we had to do that - we had a lot of switches going on with the students. Before one of our teachers decided - well, not decided - as a team, we decided that it would be best that one class got a self-contained classroom just because they were really, really struggling, and we thought that switching was just making it harder because they were kids that came in kind of behind already…We felt that they would really benefit from one teacher and more structure. Prior to that, we got notice that about a third of our fifth graders and about a half of our fourth graders were going to be doing this reading program, which we had then had to change around our classes which was - I mean, as always, like when there are changes, students typically have an adjustment period…So we had a lot of growing pains with that. Our reading teacher had to deal with half of her class chunk time taken away. Fourth grade, we were able to finagle it so that they didn't miss any class, but then the culture in their class started to tank because they missed ancillary. They went to this reading

> program doing ancillary so they all - so they saw all these kids going to PE and technology, and they knew they had to go to a reading program, which wasn't made fun them by the instructional leader in there. So we were kind of in recovery mode with that. (Post interview)

With all of these other issues this team was not able to even begin the lesson study professional development cycle.

The early elementary Montessori team (Team 2) also struggled to balance the lesson study professional development with all of the other changes they were asked to make. Several of the teachers on this team were new to Montessori or to the early elementary age group. In addition to trying to make a complete paradigm shift in their teaching, this team was under a great deal of pressure to improve its students' test scores. When trying to balance managing three grades levels of students in one class, learning the Montessori curriculum, and aligning it to the district standards, the integration of technology through lesson study professional development was too much for the team to accomplish at once.

The traditional early elementary team (Team 1) was able to get through most of the lesson study process. Although all of the teachers were adjusting to a new grade level or two, they did not have to change their teaching philosophy in the process. This team's progress stalled when one member was moved to another group and they were faced with poor student performance on the new standardized test. Even though this team had the least number of competing changes, they were still not able to devote all of their time to the lesson study professional development and technology integration. As a result they

sped through the process and chose to use a scripted lesson preventing the group collaboration and reflection that are essential components of the lesson study process.

All of the teams were faced with learning a new writing curriculum, a new science curriculum, and the adaptation of their instruction to a new standardized test. All of these changes required the teachers to attend professional development and spend more time planning, leaving them less time and mental resources to consider technology integration and lesson study professional development. The two teams that refused to engage in lesson study professional development and in this research were also teams where the majority of the teachers were new to teaching under a Montessori curriculum. It is possible that these teachers anticipated the clashing change priorities and chose to focus on Montessori over technology integration professional development.

Time. With all of their other responsibilities, the teachers universally complained about the amount of time that the lesson study professional development took to complete or they expected it would take. The principal felt that lesson study professional development was an appropriate use of one of their weekly team meetings, but most of the teams felt that they had other tasks to accomplish during this time and lesson study professional development was viewed as something extra. The traditional early elementary team (Team 1) was able to accomplish more of the lesson study professional development cycle than the other teams, but they started a full nine weeks before the other teachers.

Technology Beliefs, Knowledge, and Integration

While lesson study professional development did not have any effect on the teachers' attitudes toward technology or use of technology, several patterns emerged in the way that teachers at Openwood approached technology.

These are summarized in two main themes:

- positive attitudes toward technology
- TPACK based-decisions and technology use

Attitudes toward technology. Across all of the teachers, there were generally positive attitudes toward technology (see Table 7, Table 10, & Table 13). The teachers stated that technology skills were important in today's society and felt that technology could be used to supplement other forms of instruction. Even among the Montessori teachers, where there was a debate about the fidelity of technology integration in the Montessori curriculum, teachers reported favorable attitudes toward technology in the classroom. Most agreed that more technology resources, such as computers, were needed, and general technology use by students needed to increase.

Most of the negative attitudes about technology focused on maintaining a balance between human interaction and computer time. The teachers were not opposed to technology use, but felt that it was important not to let it replace all of the human interaction that occurs between teachers and student. Abigail, Emily, and Nathan both stated that they had seen teachers using a computer program as their whole curriculum. They felt that this deprived the students of face to face interactions with the teacher and other students. Although not explicitly stated, they may have been referring to the 5th

math class which relied heavily on Reasoning Minds math software. Hannah taught this class. She also worried about her students receiving enough off-computer time to build social skills and teamwork.

TPACK and technology use. The teachers at Openwood Elementary had technology experience and knowledge but did not use technology in transformative ways. Marianne, Lance, and Deborah all had computer backgrounds. All other teachers said that they were at least moderately comfortable with technology. Additionally, most of the teachers used some form of teacher-centered technology on a regular basis. These included using a computer and projector for whole group teacher led instruction or using individual "drill and practice" student software. A few of the teachers did mention using technology in more student directed ways such as blogs and student created Power Point presentations, but these were not observed. Some were projects that were done in the past or they planned to do, but I did not see these types of technology used in observations. Even in the computer lab, students tended to use "drill and practice" educational software.

While the teachers were not using much "transformative" technology, they demonstrated some TPACK reasoning when describing their reasons for using the technologies that they chose (see Table 15). Teachers demonstrated a lot of technological pedagogical knowledge, often citing the ability to differentiate instruction and motivate student learning by integrating technology into their teaching. The teachers used the individualized software because it allowed them to track student progress and differentiate instruction for their students. Additionally, some of these programs were

aligned with district and state content standards and the upcoming test. The school held licenses for several educational programs, but the teachers did not use all of these programs. Each of the teachers had preferences for certain programs over others and were able to articulate clearly which software they liked or disliked and why. These reasons included ease of use, but focused mainly on the rigor of the activities or alignment with the teachers' beliefs about student learning.

Table 15

Evidence of TPACK

Teacher	Reason for using or not using technology	TPACK code
Abigail	Waterford is a really good program. Used to have a printer with it but of course the printer has died and the school will not replace that. But what it used to do was that it would print a book for each child every time they got through so many lessons or certificate which was great because that was such positive reinforcement. I still think it's useful and it has three levels: primary level, a middle level, and then an upper level. It can give me a report or I could print them out if I had a printer. [Laughter] I used to send reports to parents. (Pre-interview)	TPK
Bridgette	We do story online. So you do - have read -alouds in the room, but [story online] makes it easier for the ELLs to see the illustrations and the pictures and things like that. It makes it easier for them to understand.	PCK, TCK
Christopher	But really they are using the computer in order to get more, you can see this one for example, how my students are writing because they are motivated. They are finding information. They are not copying from the computer resources. No, they are reading and then using comprehension and then using different strategies like using that kind of experiment in order to count, to get information and then after that the next step is making a summary using the strategies and that's why they have that. They can use Google supervised by me. I taught them using Google. I have to be very close supervising them very close because I have to make sure they're using just Goggle for that purpose but they use Enchanted Learning, they use e-Learning. Then I also have Brain Pop. That is the same thing for topics. (Post interview)	TPK, CK
Deborah	I think if we had good computers, I think it could many things. I think it could be diagnostic. I think it could be reinforcement. And on certain skills I think it could even teach lower students that you don't have time to teach. But, I think when you get these old, outdated, donated machines, um, it's very limited. I think what you're going to get there is, you're going to get practice basically. But it also requires that the teacher take a lot of time organizing that, because you only have 2 or 4 computers and you have 20 kids. (Pre-Interview)	TPK

Emily	I guess, mainly because the computer programs tend to be a little bit more interactive and keep your attention. And so, they've just always been presented to the schools as, "This is another type of intervention," and I know for us, Imagine Learning is one of them. It was purchased through our school and it's kind of just our school-wide intervention program. (Interview)	TPK
Gabriella	I love Edusmart for Science. I love First in Math for Math or where they track the computational facts. I love Tumble books, excellent for fluency. There are many things that I love in technology. BrainPOP. I love technology. I love Reading Counts. I love our Accelerated Reader. I think - because the kids are trying to get points but you're trying them to get to read and in their mind they're just getting points. They're not thinking, "Oh, I am reading to read." They're thinking I'm reading to get points and beat the other guy. (Pre-Interview)	TCK, TPK
Hannah	I love the Elmo because I used to write on the board, but it's so much easier to see if it's on the Elmo. Also, I've noticed that students get really confused if what you are putting on the board is not exactly what they have in front of them. For example, if you're going over a worksheet, you're like, "Okay. Well, we're going to talk about problem two. So everyone look at problem two," and it's like, "What change do we need to make? We probably need to put in an apostrophe." So like, I'll write down and then an apostrophe Wait. "Where? What are you talking about?" It's just so much easier if they can actually see, like, "Oh, she's doing the exact same thing that I am doing," and that's just easier for them also because they're so low in reading. I make everyone track with their finger, and even if they don't do that, they can see it up there tracking that and that's not something you can really do with anything else. (Pre-interview)	CK, PK,TK
Irene	This program takes them through objectives but at their own pace. So if a student is an advanced student, they'll go through objectives and look at harder and harder questions, whereas if it's a struggling student, the system can even diagnose them and send them back to remedial objectives. So in fifth grade, we also start off with a warm-up either a journal entry or do now and the rest of the class period they are on RM and I'm pulling small groups. Reasoning Mind gives me a ton of data with what they're struggling on. Then I will also do mini lessons based on the [objective] that is matching to where most the students are. (Post interview)	TCK, TPK
Kenneth	I have computers and I'm adapting the new software from [the district], the Fast Math from Scholastic and the new grammar software. I love Imagine Learning but it's just not available for everybody, but I think they should all use it. It's like having a private tutor for each child. I would do more with my projector but you know something, the priority is the individualized learning of every child and the projector is a kind of a whole group event. So I've yet to bridge the gap between small-group and individualized learning with the technology I have available. Once the projector is on, everybody's brain just shuts off and they all stare at whatever I'm doing. But I'm planning on using it with a new terrarium that we're going to replace this terrarium with one even better, or the real deal and we're going to move all of our reptiles and animals and such and plants into a new terrarium. I want to have that camera focused on it and it will be running full time. Students will be able to do their observation and zoom in and out. That also works with microscopes but the amount of time needed to spend on a microscope with this age group is not that extensive. (Pre-interview)	TCK, TPK

Lance	Well, because the children are so interested [in technology]. They respond either to the learning aspect of it, like last year I used it as a work station and so when they got to the computer, they would log into the Reading Street account, they would do their activities. So, that was the main reason. It's a big part of our curriculum. (Interview)	TPK. CK
Marianne	Before I became an elementary school teacher, I was a high school teacher, and I was in charge of the computer center. So I have many computers and I have to be in charge of explaining and teaching the children all these applications and programming. That was many years ago. [Laughter] It's easier when you are focused on one thing. If I had to focus only in technology, I will do great because that's all I had to do. Teach them how to use the computer, keyboarding, how to do presentations - PowerPoint presentations - how to use a word processing program, how to create a word processing document, how to do spreadsheets. Whatever is necessary. I will teach them how to use a blog and how to create a blog and things like that, but it's not only that. Then having children, it's even more difficult because you have three different stages. First grade, second grade, third grade. The third graders of course are a little more advanced than the first graders and it's hard to teach individual. When you're doing computer, you need to have a set of computers and everybody needs to be on the same page. You know what I'm saying? It's because it's really hard to give individual lessons on technology. How can you get the time to do that when you have to do Math, Reading, Language and Science and all of these other things? So integrating technology in the classroom is actually really difficult for me. It's not that it's a difficult subject. It's just time-wise. I mean, yes it's hard to integrate it into. I try to do it as much as I can, but I wish I had more time and more computers and more room to put more computers so I can have at least five students. Like a small group of students to teach them something because giving them an individual lesson takes forever. (Pre-interview)	TK, TPK
Nathan	I've got approved with Study Island just now. I was using Fast Math but I didn't like it after I used it because you can put whatever answer and it doesn't show you where you got it correct or wrong. So that's part of why I don't use it. It's horrible. (Interview)	TPK, TCK, PK

Finally, many of the teachers were capable of generating ideas about transformative ways to use technology, but they chose not to because of times constraints, lack of resources, or a low perceived value of the activities.

Summary

The teachers at Openwood elementary school faced a number of change initiatives in the 2011-2012 school year. With all of these competing school goals, the teachers found it difficult to devote time to the lesson study professional development. This lack of time led to two teams refusing to participate in the lesson study professional

development and two additional teams being unable to complete the lesson study cycle despite initially agreeing to the professional development. Only one team was able to plan, revise, and re-teach a lesson, but their collaboration during the lesson study process was shallow. Because of these limitations, no change was seen in the teachers' technology beliefs, TPACK, or technology integration in the classroom. The implications of these findings are explained in the following chapter.

Chapter 5: Conclusion

The push for technology integration in schools has increased over the last decade (ISTE, 2007, 2008, 2009). Professional organizations and individual school districts have created technology standards for both students and teachers (Partnership for 21st Century Skills, 2009; National Educational Technology Plan, 2010). The question now is how to help teachers and their students meet these new standards for technological knowledge and skills. This study focused on one school's attempts to increase the technology integration on its campus using an in-depth lesson study professional development. This research followed three teacher groups through their experiences in the collaborative professional development. This chapter discusses this study's findings, limitations, and future research directions. Teacher educators, school administrators, and classrooms teachers may learn from the findings of this qualitative case study.

Interpretation of Findings

This qualitative research led to two major categories of findings. The first set of finding deals with the technology-infused lesson study. This section looks at the factors associated with the implementation and completion or stagnation of the lesson study process within each teacher group. The second set of findings deals with the teachers' technological pedagogical content knowledge, TPACK, and their use of technology in the classroom. Even though two of the three groups of teachers did not complete the professional development, all of the teachers participated in interviews and observations about their beliefs, knowledge, and uses of technology. The connections between

TPACK and technology use, as well as possible implications of this, are discussed in this second section.

Technology-Infused Lesson Study Professional Development

The technology-infused lesson study professional development initiative at Openwood Elementary School was largely unsuccessful. Only three of five teams even agreed to participate in the mandatory professional development, and only one of those three was able to start the lesson study cycle. The following sections discuss factors that may have contributed to the stagnation of the technology-infused lesson study professional development at Openwood Elementary.

Japanese versus American public schools. Lesson study professional development was adapted from Japan. This practice of professional development has a long-standing history in Japan (Stigler & Hiebert, 1999). However, as it spreads throughout the U.S., researchers have found that there are several differences in the ways that Japanese and American teachers approach the lesson study process. These differences help explain the limited penetration of LSPD at Openwood Elementary and may assist in guiding more successful adoption of LSPD within the American public school system.

Location and participants. In Japan, lesson study professional development, LSPD, can occur through a number of channels: individual schools, regional school offices, and independent organizations (Watanabe, 2002). Openwood Elementary School implemented school-based LSPD, the most common form. These LSPD are conducted by the teachers within one school site. Occasionally outsiders are brought in to

participate in the observation and revision of the initial lesson. Lab schools, which are usually affiliated with Japanese universities, draw large crowds of teachers to observe and reflect on the lessons produced during the lesson study collaboration (Watanabe, 2002). LSPD also occurs at the regional level, much like districts in the U.S., in which the teachers within a regional work together to complete the lesson study. The final channel for LSPD is through private organizations. In this type of LSPD, teachers work outside of school time with small groups to participate in the lesson study cycle (Watanabe, 2002). Having different levels of LSPD allows teachers some choice in who they work with during the process. It also allows teachers to learn from a wider base of people.

Team 3 may have been more motivated to work on lesson study if they were given an opportunity to collaborate with teachers in the same content area. In interviews, Hannah suggested that working with teachers from across the district would be very helpful. She was the only teacher in her team teaching writing, so working with teachers outside of her team or school would have given her the opportunity to work with someone who was teaching the same subject matter content. District-wide or cross school lesson study professional development may be an appropriate option for small schools where teachers do not have overlapping grades and subject matter.

Collaboration. In the U.S., collaborative planning and peer observations are not commonly practiced. Fernandez (2002) felt that moving from an isolationist to collaborative culture is one of the most difficult adjustments that U.S. teachers must make when beginning lesson study professional development. Puchner and Taylor

(2004) also noted this issue as teacher groups in Illinois attempted LSPD for the first time. In particular, the teachers struggled to balance their individual autonomy with group collaboration. While the teachers at Openwood Elementary School had participated in weekly team meetings, or professional learning communities, for several years, these meetings were not used for collaborative lesson planning. Collaborative lesson planning suffered in many of these teams due to leadership, timing issues, and other pressures. Team 1 circumvented the need to share instructional ideas and critically reflect as a group by choosing a pre-written lesson. The other teams were unable to even reach the lesson planning stage of LSPD. Although they did not engage in collaborative planning, the teachers at Openwood were open about problems that occurred in their classes and often asked for suggestions for help within their teams. All of the teams discussed teaching and student problems freely during their team meetings held in another teacher's classroom, sharing their concerns and asking for advice when meeting together. The teachers were less open when meeting in the principal's office but not completely unwilling to share ideas if asked. This openness may have allowed for an easier transition to using LSPD has the other necessary elements of LSPD been present at Openwood. The teachers also reported a feeling of "having each others' back" within their teacher team. It may be that the standardized testing and other pressures created a sense of cohesion within the teams. They seemed to feel responsible for helping each other succeed and protecting each other against the accountability of the school and district administration.

Peer observations, however, were new to the teachers of Openwood Elementary, but the teachers who participated did not appear to have a problem with others observing their classroom. Most of the teachers in the three consenting teams were open to my unscheduled observation of their team meetings. Only Gabriella and Lance had reservations about my observation of their class. Lance did not allow me to observe his classroom at all, and Gabriella waited until she had a self-contained classroom before I was allowed to observe her unannounced. These two teachers appeared the most self-conscious and unsure of themselves as teachers. Only Team 1 made it to the observation portion of the LSPD. Emily stepped up to teach the lesson for her team, but the other teachers on the team were also willing to allow their teammates into their room. For the most part, teachers at Openwood felt confident in their teaching skills and safe enough in their teams to open their classrooms to each other. They also appreciated the opportunity to observe their peers. It seems that the walls of the isolationist teaching culture were beginning to come down at Openwood, and teachers were open to more a collaborative environment.

As mentioned earlier, the Openwood principal started requiring the teachers to participate in weekly tem meetings several years ago. For the first few years, the principal facilitated these meetings in her office. The year of the study was the school's first attempt at team-led weekly meetings. It is possible that the existing school culture of teacher meetings allowed Openwood teachers to be more open to the collaboration and observation components of LSPD.

Showcases and publishing. Another key component of lesson study professional development in Japan is the public aspect of collaboration in their LSPD process. In Japan, "the groups forge links with one another and share their lesson study work by publishing reports; by presenting lessons to colleagues outside their groups; by involving outside advisors who enrich, deepen, and spread the ideas generated by different lesson study groups; and by focusing on common curricular goals"(Chokshi & Fernandez, 2005, p. 675). In the case of Openwood Elementary, no other schools in the area were participating in LSPD or were invited to engage in the LSPD with Openwood elementary teachers. The teachers were told that their lesson study professional development reflective reports would be collected and published for other teachers at Openwood to read and use in the future. This did not seem to motivate the teachers to want to complete the LSPD and was not emphasized after the initial training. Since there were so few teachers per grade level at Openwood, having their documents available only to the others teachers on campus may not have seemed helpful. None of the teacher groups completed the reflective document. Adding a more public component or showcase that involved teachers and administrators outside of Openwood to the LSPD may have given the teachers a stronger sense of accountability for their progress in the process.

Critical research lenses. In an investigation of a joint Japanese and American lesson study, Fernandez, Cannon, and Chokski (2003) noted a difference in the way that Japanese and American teachers approached the lesson study professional development. The Japanese teachers took a research approach, deciding on a central learning goal and continually reflecting on that goal. They made decisions about lessons based on whether

or not that lesson would accomplish the research goal. American teachers also chose a research goal, but did not refer to the goal in their selection of the lesson. Instead, in choosing the lesson, they purposefully avoided common learning objectives that they felt were dry or boring. They talked about choosing a lesson that was interesting for the observers to see and based on an objective that they all needed to teach rather than ensuring the lesson related back to the group's goal (Fernandez, Cannon, & Chokshi, 2003). This critical research lens, in which teachers start with a research goal and then actively work to improve their practice around the goal, is a crucial component of lesson study. Like the American teachers in the study above, the teachers at Openwood lacked the critical research lens of the Japanese teachers. Team 3 struggled to start LSPD because they could not think of an objective that all of the teachers would need to teach. Neither Team 1 nor Team 2 clearly nailed down a learning goal before jumping into the process picking a lesson. Team 1 chose a scripted science lesson because they all needed to teach the new curriculum, and they liked the hands-on activities involved in that curriculum. Having a more comprehensive training on the purpose of LSPD might have helped shift Openwood teachers' mindsets going into the lesson study process. Explicitly setting aside time for the teachers to discuss the research lens and choose a goal could have helped teachers move away from an execution focus to a research-based learning focus.

Since technology integration was one of the school's goals in using lesson study, more time may have been needed to reinforce this campus goal and set expectations for the teachers. Additionally, having team leaders continually remind their team of the

technology integration goal might have helped maintain a learning focus around technology use throughout the process. Without this initial motivation and continued reminders, Team 1 did not include any technology in the lesson that they choose, nor did they add technology to the lesson revisions.

The new scripted curriculums and heavy testing accountability may be another reason why teachers at Openwood did not take a research or learning focus. The combination of these factors led to the teachers feeling a lack of autonomy in their teaching. Montessori teachers especially struggled with maintaining their own personal beliefs about teaching and learning in the face of the public school setting. If American schools desire teachers to adopt the research focus existing in Japanese lesson study groups, they may need to look for ways to empower the teachers so that they are motivated to improve their teaching practice.

Meaningful school change. Fullan (2007) described meaningful school change as a process that leads to the a) use of new teaching *materials*, b) the use of new teaching *strategies*, and finally c) a change in teaching *beliefs*. At Openwood, the goal of lesson study professional development was to integrate technology into the classroom. Through this professional development process, computers and digital technologies were the intended new *materials* to be used in the classroom. These technologies were to be used in socio-constructivist ways or using socio-constructivist teaching *strategies.* Finally, it was proposed that the reflection built into the lesson study cycle would lead to new teacher *beliefs.* Even with this alignment to a meaningful change experience, the lesson study professional development was unsuccessful and did not lead to meaning change at

Openwood. Fullan (2007) outlined three areas that can influence implementation of an innovation: a) characteristics of the change or innovation, b) local characteristics, and (c) external factors. From an educational change perspective, technology- infused lesson study professional development is the innovation in and of itself and several factors affected its implementation at Openwood. These factors are discussed in the following sections.

Characteristics of the change. Characteristics of the changes include the perceived need for the change, the clarity of the change needed and the solution, the complexity of the changes that are required, and finally the "quality and practicality of the change project" (Fullan, 2007, p. 91). Technology-infused lesson study professional development fell short on many of these criteria, contributing to limited implementation at Openwood.

Perceived need. While the teachers and principal at Openwood reported technology integration as an important change needed on their campus, they were also faced with a number of other competing change initiatives. The perceived need of a change must be considered in relation to all of the other changes and responsibilities that require teacher and administrator time and action. One issue with combining multiple school change initiatives is the limitations of the school's time, monetary, and personal capacity (Hatch, 2000). While many change initiatives provide schools with extra support (e.g., technology equipment, grant money, and training), these resources usually do not compensate fully for the costs of the change within the school (Hatch, 2000). At Openwood Elementary School, both the label of Science Magnet and the Montessori

charter were directly connected to additional funds. However, these two programs required several hours of teacher professional development as well as changes in the instruction on campus. Without evidence of these changes in behaviors, Openwood would not receive future funding for these two change initiatives. The state-wide initiative of new standardized tests was also tied to monetary support for the schools through student performance on the tests. The new writing curriculum did not have a direct monetary backing, but was touted as a way to improve the writing scores on the state tests. The district administrators, principal, and some teachers thought that the new writing curriculum would indirectly be able to increase the school's future budget through its connection to the student test scores. Only the technology initiatives did not provide any monetary assistance. Without this monetary incentive, technology-infused lesson study fell to the bottom of the principal's and teachers' priority list.

With so many competing concerns, Fullan (2007) discussed the importance of communicating an expressed need for the any new change initiative. The principal and teachers at Openwood felt that technology-integration was important for their students, but this was not enough to motivate teacher teams to pursue the technology-infused lesson professional development. Fullan stated that "it is a question not only of whether a given need is important, but also how important it is relative to other needs" (2007, pg. 88). He went on to explain that during the implementation stage teachers must feel that "the needs being addressed are significant *and* that they are making at least some progress toward meeting them" (2007, pg.89). In this case, it is possible that the teachers

and principal perceived that improved student performance on standardized tests was a more immediate need than technology integration.

Clarity. Clarity of the change goals and the process for the change are both needed in order for meaningful change (Fullan, 2007). At Openwood, there was very little clarity on what technology integration meant across the campus. Teachers gave varying definitions of technology integration in interviews. Additionally, the principal had her own view of technology integration that was never shared with the teachers. This lack of consensus of technology integration led to teachers using technology in a number of different ways across the campus.

Clarity of the change process itself is also important. Since the intended initial half-day training was cut, teachers were given only a brief overview of the lesson study process. As mentioned in the previous section on lesson study in American public schools, American teachers may need more training on the process and purpose of lesson study professional development in order to implement it fully. This training was not present at Openwood. Despite multiple planning meetings between the principal and myself, it is possible that she did not fully understand LSPD and the importance of its components either.

Complexity. Successful implementation of a change also depends on the complexity of that change (Fullan, 2007). However, this does not mean that schools should only attempt simple changes. "Simple changes may be easier to carry out, but they may not make much of a difference. Complex changes promise to accomplish more…but they also demand more effort, and failure takes a greater toll" (Fullan, 2007, pg. 91).

Technology-infused lesson study professional development was complex change for the teacher at Openwood. This form of professional development required more time and effort than the professional development that they were accustomed to attending. In LSPD, teachers were asked to work together over the course of several meetings to plan, execute, revise, and reflect on a lesson. In addition to the lesson study process, the teachers were asked to integrate technology into their group lesson. Overall the teachers at Openwood were comfortable with technology, but may not have known how to integrate technology in transformative ways. Ultimately, Team 1 did not include technology in their lesson. It is possible that bringing a technology specialists or other knowledgeable other into the team may have helped them overcome this complexity issue and integrate technology more successfully.

Quality and practicality. The final characteristic related to the change itself is the quality and practicality of the change. Fullan (2007) acknowledged that worthy changes may be stalled due to a poor quality implementation. Poor quality implementation can occur when the changes are implemented too quickly without proper planning of materials and support (Fullan, 2007). A number of factors led to a poor quality implementation of technology-infused lesson study at Openwood. First, elimination of the training sessions reduced the teachers' understanding of the purpose of lesson study and technology integration. Secondly, there was a lack of consistency between the teacher leaders facilitating the lesson study process. Again, these leaders may have benefited from more comprehensive facilitator training. Timing was another factor in quality of the implementation at Openwood. Clausen et al. (2009) found that in order for

teacher learning communities to be sustainable, teachers needed a flexible schedule that allowed for teacher collaboration. At Openwood, teachers were tasked with completing the lesson study during their weekly team planning meetings. However, the teacher groups had many other tasks that they were also supposed to accomplish during this time. Without having a time set aside specifically for technology infused lesson-study professional development, the teachers at Openwood Elementary School were not able to fully complete the process.

Local factors. The contextual factors of the district and school setting are also important for understanding the implementation of a new change. This contextual setting includes the school district, the community, the principal, and the teachers (Fullan, 2007).

School district. The technology-infused lesson study professional development at Openwood was a school-based innovation enacted through teacher teams, but it had to compete with other district mandated innovations. The new title of science magnet school, the Montessori growth initiative, and the new writing curriculum all had district level support and accountability. With so many competing innovations and without district level accountability measures, technology-infused lesson study was not treated as a priority by the principal or the teachers. When pushed to manage their limited time and resources, only Team 1 was able to complete any of the LSPD steps.

Community characteristics. Community members, school board members, and parents can also influence the implementation of a change at a school. The principal stated that the parents supported technology integration and that Parent Teacher Organization had pledged to raise money for more technological resources on campus.

This group was not directly involved in supporting the technology-infused lesson study professional development. It is probable that they did not even know that this professional development was being implemented in the school.

Principal. Fullan (2007) discussed the importance of administrator support in his book. Summarizing the literature on school and educational change, Fullan concluded that a "principal's actions serve to legitimate whether a change is to be taken seriously (and not all changes are) and to support teacher both psychologically and with resources" (2007, pg. 95). During the planning stages, Openwood's principal was very supportive of the lesson study professional development process. She committed to giving the teachers the time that they needed to complete the process and to provide substitute teachers so that they would all be able to observe the research lesson. She also included the technology-infused lesson study as a mandatory professional development in her technology improvement plan for the school. However, once the school year started and the professional development began, her direct advocacy of the lesson study professional development disappeared. The principal felt that the teachers had adequate time in their existing weekly team meetings to conduct the lesson study process and did not offer additional time for the process. Additionally, there was no accountability system in place for the lesson study professional development. The principal did not check on the teachers' progress or require any evidence that the teams were participating in the lesson study professional development. With this diminished principal role, only one team was able to plan, observe, and revise a research lesson.

Teachers. Individual teacher characteristics influence their willingness and ability to participate in the change process. A teacher's psychological state falls within these individual characteristics. In Team 2, both Lance and Marianne reported feeling tired and stressed out. They were the most concerned about their groups' ability to complete the LSPD in the allotted time frame. Teachers who were more secure in their teaching were less likely to be resistant to the collaboration and peer observation involved in lesson study professional development.

Since LSPD is conducted with team of teachers, understanding the group dynamics within the school and grade level teams is also important understanding the implementation or lack of implementation of LSPD. Fullan (2007) argued that "the quality of the working relationships among teachers is strongly related to implementation. Collegiality, open communication, trust, support and help, learning on the job, getting results, and job satisfaction and morale are closely related" (p. 97). In interviews the teachers at Openwood reported there being a much higher level of collegiality on the campus than in past years. Despite this sense of trust and support among the teachers, many of them were unsatisfied with their job reporting high levels of stress and an inability to keep up with the job requirements. It was this stress and lack of time that kept Teams 2 and 3 from completing the LSPD. It is possible that these factors also affected Team 4 and 5's decisions not to participate in the LSPD at all.

External factors. Governmental and other agencies can also influence the implementation of a school change (Fullan, 2007). In the case of Openwood, the principal's technology professional development program spurred her to look for ways to

increase technology professional development on her campus. This outside agency did not direct her to choose LSPD, it only acted as an impetuous for the change toward more technology integration. This impact of this external factor was initial excitement and motivation on the part of the principal. That influence waned as the project went forward.

Technological Pedagogical Content Knowledge and Technology Integration

Regardless of teaching experience, the teachers at Openwood Elementary School all reported feeling confident with technology. Previous research found that novice teachers reported feeling more confident in their general technology use, but were less likely to use technology in the classroom (Russell, Bebell, O'Dwyer, & O'Conner, 2003). This dissonance could be due to a lack of content or pedagogical knowledge. At Openwood, Hannah and Irene each had only two years of teaching experience, but were given the most technology-rich classrooms. Their technology use was greatly impacted by the availability of technology in their classes.

Although most of the teachers used some technological pedagogical content knowledge in their choices regarding technology, their decisions did not lead to transformative technology use. The majority of computer use was intelligent tutoring software. It is possible that the teachers were unable to use technology in a transformative ways not because of a lack of technology knowledge, but rather a lack of transformational pedagogical knowledge. Previous research has found that teachers' beliefs about teaching influence their technology use in the classroom (Ertmer, 1999; Neiss, 2005; Ravitz, Becker, & Wong, 2000; Sang, Valcke, von Braak & Tondeur, 2010).

This is illustrated in this research through a comparison of the Montessori and traditional teachers. When asked about their role as a teacher, "facilitator" was the most frequent answer from both the Montessori and traditional teachers. However in observations and explanations of their lessons, the traditional teachers focused on a lesson cycle beginning with direct instruction followed by student practice. Only the Montessori teachers described their lessons in a socio-constructivist manner where the environment was set up to encourage individual student exploration and learning. The Montessori teachers also spoke frequently of building critical thinking skills in their students. All of the Montessori teachers discussed individual student research as a way that they used or wanted to use technology in their classes. Of the traditional teachers, only Christopher allowed his students to conduct research using the computers. These beliefs about pedagogy influenced how they chose to use technology in the classroom, with Montessori teachers using slightly more socio-constructivist practices with technology.

Even teachers with socio-constructivist teaching beliefs and practices may need outside expertise to use technology in transformative ways. Hughes, Guion, Bruce, Horton, and Prescott (2011) proposed a Framework for Action (FFA) that involves outside experts, who are familiar with the change process and characteristics discussed above. In the FFA, these experts intervene at various critical decisions points during the implementation. Lesson study research also cites the ability of outside experts as helpful during the planning and revision processes (Chokshi & Fernandez, 2005). During planning at Openwood, it was discussed that the new technology teacher would serve as this outside expert in the LSPD when needed. However, with her teaching schedule, the

technology teacher was unable to meet with the teacher groups. The groups were told that they could go to her for assistance, but none of the groups did. It may be that the teachers were unaware that they needed an outside expert for technology integration. As mentioned earlier, there was no consensus of the expectations or definition technology integration on the campus. While teachers expressed a need for more technology in the classroom, their concerns focused on getting more equipment and time for the students to use the programs that were already available. Even in the computer lab, students used the computers to access educational games, stories online, or one of the intelligent tutoring programs used on the campus. Having a well-articulated or collaboratively developed vision for technology integration at Openwood may have increased the likelihood of teachers using teaching in transformative ways. If transformative use of technology is desired, clearer expectations and expert personnel is needed to help push teachers toward this type of technology integration.

The teachers cited a lack of computers as the main reason for their limited technology use. This is consistent with previous research in the field (Gray, Thomas, Lewis, &Tice, 2009). The teachers used computers mainly as a station. Additionally, the software decisions tended to be influenced more by the availability of the software at school than the quality or pedagogical connectedness of the software to the class content. Only Nathan chose to use a software program that was not readily available at the school. He used his supply budget to purchase licenses for his class. If districts and administrators want teachers to use more transformative technology, they need made to start by reevaluating the hardware and software that they are providing to the teachers.

Hughes et al. (2011) calls for more Web 2.0 tools to be introduced into the schools. They proposed that "openness and social interaction inherent in Web 2.0 support learners in generating and refining their understandings, as they read, reflect, and create new content to share with others" (Hughes et al., pg. 54). Much of this type of technology has been restricted in U.S. public schools, but these barriers need to be re-evaluated if we hope to move toward more transformative technology use in our schools.

Limitations and Rigor

As with any research, especially studies conducted in naturalistic settings, limitations arose when designing and conducting the investigation in technology-infused lesson study professional development. These limitations and measures to ensure qualitative rigor are discussed in the following sections.

Measuring and Defining Technology Integration

As noted in the literature review, the definition of technology integration has shifted over the years. This research defined technology integration as the use of technology in constructivist and socio-constructivist ways to support learning in content areas (Read et al., 2011). The framework of Technological Pedagogical Content Knowledge, TPACK, (Mishra & Koehler, 2006) was used to investigate the individual teacher's knowledge, beliefs, and reasoning as they integrated technology in their classrooms. Even with this framework, capturing and measuring an individual's thought processes can be complex. The teachers' reasoning and intentions were usually not obvious during class observations. In the interviews, teachers gave more concrete examples of technology use and explained their intentions, but this information was

based on their memories and could have been biased by the interview questions. It should also be noted that teachers do not always act in accordance with their stated beliefs (Calderhead, 1996; Fang, 1996). Triangulation of several class observations, interview data, and group meetings was used to gather the fullest possible picture of these teachers and their technology knowledge, beliefs, and use.

An additional challenge with measuring teacher's TPACK lies in the fuzziness of the framework itself. Graham (2011) argues that the overlapping TPACK categories lack parsimony and are therefore difficult to distinguish. The use of the pre-established TPACK codebook (2011) reduces some of these issues, but discriminating between two overlapping domains is still problematic. In conversations and interviews the teachers often list multiple reasons for using a specific technology. These reasons may fit into multiple domains. In this study, I clearly defined each of the domains and used the TPACK codebook evidence as operational definitions for each domain to reduce the ambiguity of the TPACK framework. Moreover, the rich descriptions and original quotes from the teachers allow the reader to understand how each of these domains is identified and defined in this paper.

Field-Based School Setting

Working in real school settings allows researchers to gather information about how professional development works in context. Researching in the field also presents its own set of challenges and limitations. Unlike a laboratory setting where the researcher can control outside variables, the priorities of the school administration and teachers take precedence in field research. This means that the context of the study is

continually changing. In this study, unforeseeable and uncontrollable school and district factors prevented most of the teams from even starting the lesson study process.

While this uncontrollable setting can be seen as a limitation, documenting the process of professional development in a natural setting allows researchers and educators to richly describe the complexity of implementation that is likely not visible in a lab experiment. With that in mind, I tried to minimize my interference in the LSPD process as much as possible so that I could document what naturally occurred in the school setting.

Participation and Sample Size

This study also reflects a limited sample of teachers. The research was based only on teams that agreed to participate in the professional development. Although all teachers were told that the lesson study professional development was mandatory, some teacher groups refused to complete or engage in the process. Without any accountability or follow-up from the administration, these teams were allowed to ignore the mandatory training. The teachers in these teams were still asked to participate in the surveys, interviews, and observations, but only one teacher consented and was observed. There may be important differences in the teams that chose not to participate in lesson study, but this research was unable to capture that information.

Conversely, focusing on a small population of teachers allowed me to conduct an in-depth investigation of the teachers on the three consenting teams. With the limited number of teachers, I was able to conduct numerous class observations, interviews, and attend the teacher team meetings on a regular basis. Large scale investigations of

professional development are not able to capture the variety and richness of data that are captured in case study analysis.

Another limitation of this population is the fact that it is mainly teacher focused. While information was collected about the principal through informal conversations, meetings, and informal observation, no interview was conducted. As the study developed it became apparent that the principal's actions and decisions were influencing the teachers' actions and behaviors in the lesson study professional development. While insight into those decisions might have been helpful in the study, the principal was not the intended focus of this study. Additionally, I felt that interviewing the principal might open the door to questions or conversations that violated the privacy and confidentiality of the teachers involved in this study. Rather than put myself in a potentially unethical situation, I decided not to conduct an interview with the principal.

Length of Time

Change, especially in our well-established school system, is a long and difficult process (Fullan, 2007). Fullan describes three stages of change starting with adoption through continuation. Each stage can take several years and schools often experience numerous setbacks before continual use is achieved (Fullan, 2007). In this study of one semester, it was impossible to capture the whole change process.

Trustworthiness

Without checks on the trustworthiness of data collection and analysis, qualitative research loses much of its rigor. In this study, I took several measures to ensure the quality of the research and my findings. The first step was to collect several different

data sources so that my results could be verified through triangulation of data (Corbin & Strauss, 2008). Secondly, I spent an entire semester collecting data at Openwood Elementary School. Even when not attending teacher meetings, conducting interviews, or conducting formal observations, I spent time walking around and sitting on campus to gain a better sense of the school community and atmosphere. I took extensive field notes from these observations. This prolonged engagement with the teachers and the school setting is not always possible, but when present in research it allows the researcher to experience things that may not be possible when only observing selected or pre-scheduled events (Guba, 1981). Finally, I continually discussed my findings and any potential biases with advisors and peer researchers throughout the data collection and analysis process. These discussions, along with the triangulation of data mentioned earlier, helped to increase the confirmablility of my findings.

Suggestions for Future Research

This qualitative study is just a beginning look into the way that lesson study professional development can be adapted to help teachers integrate technology into the classroom. In order to determine the contexts in which this type of professional development is successful, more research is needed. Research is also needed to better understand the interplay of the technology-infused lesson-study professional development with teachers' beliefs, attitudes, and use of technology.

When considering the viability of an intense professional development like lesson study, future research should focus not only on the teachers in the lesson study professional development but on the entire school community. Educational change

involves teacher, parents, administration, and students. The impact of the principal is explored briefly in this study, but she was not interviewed about her intentions and decision making process in regards to the lesson study professional development. As previously mentioned, the perceived need of the intervention also affects the success of the change. The role of parent and community support may influence teachers' perception of the change and the change process. This is an area that future research should explore.

In these systemic studies, researchers should also examine reasons why teachers resist this technology-infused lesson study professional development. Are these teachers resisting the form of professional development or the technology integration? Understanding the motivations of teacher resistance to lesson study can help administrators and professional developers modify the professional development to better appeal to this group of teachers.

In addition to taking a more systemic look at the lesson study process, future research should compare schools that have teacher-initiated collaboration to schools where lesson-study professional development has been implemented by the administration. These studies should investigate the sustainability and scalability of this professional development and the role of the teacher leaders in this teacher collaboration.

Finally, it important that future research investigate the teacher and student outcomes that may be attributable to technology-infused lesson-study professional development. The goal in any professional development is to positively impact student learning. Before any teacher professional can be deemed effective, experimental studies

should determine the actual effects of the professional development on teacher beliefs, teaching behaviors, and student learning. While it difficult to isolate the impact of teacher training on individual student objectives, this is a goal that all researchers in teacher education should continually strive to accomplish. As the body of research expands and statistical models improve, these types of results are becoming more obtainable.

Summary

As originally designed technology-infused lesson study professional development has the components of effective professional development (Hunzicker, 2010), but it is clear from these case studies that without sufficient support and direction teachers will not be able to implement the process. Without proper implementation, the professional development was ineffective in changing the teachers' technology beliefs, knowledge, and behavior. In future attempts to execute this type of professional development, administrators, teacher educators, and researchers should consider the contextual factors.

Appendix A: Technology Integration Assessment Rubric

(Harris, Grandgenett, & Hofer, 2010)

Criteria	*4*	*3*	*2*	*1*
Curriculum Goals & Technologies (Curriculum-based technology use)	Technologies selected for use in the instructional plan are strongly aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are partially aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are not aligned with any curriculum goals.
Instructional Strategies & Technologies (Using technology in teaching/learning	Technology use optimally supports instructional strategies.	Technology use supports instructional strategies.	Technology use minimally supports instructional strategies.	Technology use does not support instructional strategies.
Technology Selection(s) (Compatibility with curriculum goals & instructional strategies)	Technology selection(s) are exemplary, given curriculum goal(s) and instructional strategies.	Technology selection(s) are appropriate, but not exemplary, given curriculum goal(s) and instructional strategies.	Technology selection(s) are marginally appropriate, given curriculum goal(s) and instructional strategies.	Technology selection(s) are inappropriate, given curriculum goal(s) and instructional strategies
"Fit" (Content, pedagogy and technology together)	Content, instructional strategies and technology fit together strongly within the instructional plan. .	Content, instructional strategies and technology fit together within the instructional plan.	Content, instructional strategies and technology fit together somewhat within the instructional plan.	Content, instructional strategies and technology do not fit together within the instructional plan

Harris, Grandgenett, & Hofer (2010), p. 8

Appendix B: Pre-Interview Protocol

Philosophy of Teaching

1. Describe a typical lesson in your class.
2. Describe your role as a teacher.
3. Describe an ideal student.

Technology Attitudes

4. What role do you think that technology should play in schools?
5. Are there situations when technology use is more or less appropriate? If so, when?
6. How comfortable do you feel using technology?

Technology Use

7. What types of technology do you use in your classroom?
    a. When did you start using (technology mentioned above)?
    b. Describe how you use that technology in your class.
    c. Why did you start using that technology?
    d. What was your teaching like before using it?
    e. How did it change?
8. Describe how technology is used at (school name).
9. How does that affect your technology use?

Appendix C: Post-Interview Protocol

Philosophy of Teaching

1. Describe a typical lesson in your class.
2. Describe your role as a teacher.
3. Describe an ideal student.
4. Do you feel that this has changed due to the lesson study professional development? If so, how?

Technology Attitudes

5. What role do you think that technology should play in schools?
6. Are there situations when technology use is more or less appropriate? If so, when?
7. How comfortable do you feel using technology?
8. Has this changed as a result of the lesson study professional development? If so, how?

Technology Use

9. What types of technology do you use in your classroom?
    f. When did you start using (technology mentioned above)?
    g. Describe how you use that technology in your class.
    h. Why did you start using that technology?
    i. What was your teaching like before using it?
    j. How did it change?
10. Describe how technology is used at (school name).
11. How does that affect your technology use?
12. At the close of the lesson study, what are your intentions for using technology in the future?

Lesson Study Group

13. Describe a typical group meeting.
    a. Things discussed
    b. Unanimity of the group
    c. How you dealt you disagreement among the members
14. Do you feel that you changed as a result of the lesson study professional development? If so, how?
15. Do you feel that (group member name) has changed as a result of participating in this lesson study group? (repeated for each group member)
16. In the future, what changes would you make to the lesson study process?

Appendix D: TPACK Codebook

(Hughes, 2011)

Technological Pedagogical Knowledge (TPK)

Evidence:

1. Motivating students through technology
2. Differentiating instruction when technology is used
3. Ability to organize collaborative work with technology
4. Holding students accountable for equipment used
5. Developing strategies for assessing student work with technology
6. Knowing about the existence of a variety of technological tools for particular general pedagogical tasks
7. ~~Ability to choose a tool based on fitness with content and learning goals~~ [2]
8. Ability to repurpose commercial software for general teaching
9. Knowing about the time required to teach with particular technologies
10. Ability to envision potential student problems with particular technologies and plan relevant activities to support those students
11. Generating alternatives in the event of technological failures
12. Ability to explain a computer procedure to students (e.g., through modeling)
13. Knowledge of NETS-S – expectations for students' technological literacy
14. Using technology for lesson planning preparation
15. Using technology for general assessment (e.g., grading, portfolios)
16. Knowledge of infrastructure at school site

Technology Knowledge (TK)

Evidence:

1. Operating computer hardware
2. Using standard software tools (e.g., MS Word etc.) for non-educational use
3. Installing and removing peripheral devices (e.g., USB drives, microphones etc.)
4. Troubleshooting equipment
5. Using appropriate vocabulary
6. Knowledge of current and emergent technologies in society

[2] This item was not used because it was removed from the codebook by Hughes, 2010.

Content Knowledge (CK)

Evidence:

1. Knowledge of concepts, principles, and relationships in a curricular domain
2. Knowledge of the rules of evidence and proof

Technological Content Knowledge (TCK)

Evidence:

1. Knowing about the existence of a variety of content tools for particular content tasks; especially tools that experts in this field might use.
2. Operating / knowledge of content-based technologies in which content learning is foregrounded
3. Knowledge about the ways in which content and technology reciprocally related to one another

Pedagogical Knowledge (PK)

Evidence:

1. Knowledge of general teaching methods and strategies
2. Checking for understanding
3. Knowledge of learners and their background
4. Knowledge of general assessment strategies (e.g., tests, oral, project-oriented tasks)
5. Classroom management techniques
6. Lesson planning activities and preparation

Pedagogical Content Knowledge (PCK)

Evidence:

1. Knowledge of teaching /representing subject matter to students (e.g., techniques, representations, analogies)
2. Identifying and addressing student subject-specific misconceptions or mistakes
3. Content-specific assessment strategies

Appendix E: Open Codes

Active learning: (used in interviews and class observations) The teacher either used or described a lesson in which students were actively participating in constructing knowledge.

Analyze data: (used in interviews) The teacher talks about using student data to make decisions about what objectives to teach.

Assessment: (used in interviews) The teacher discussed assessing students. This code included comments about the importance of assessment, the logistics of assessment, and the pressures related to multiple assessments. Benchmark Testing and Common Assessments were two specific types of assessments that were mentioned.

Bilingual: (used in interviews and class observations) This code was used when the teacher talked about the importance or differences related to bilingual education. It was also used in observations of bilingual classes

Change: (used in interviews) The teacher discusses changes that he or she has made or changes that school has undergone in the past year.

Change from PLC: (used in interviews) The teacher explains how he or she has changed due to their participation in their team meetings.

Change from LSPD: (used in interviews) The teacher explains how he or she has changed due to their participation specifically in technology-infused lesson study professional development.

Changes to LSPD: (used in interviews) The teacher gives suggestions for improving the Technology-Infused Lesson Study Professional Development.

Children move around: (used in interviews and class observations) The teacher states that her students move freely around the classroom, or students are observed moving freely in the classroom during an observation.

Citizenship: (used in interviews) The teacher discusses the importance of creating good citizens and modeling citizenship in the classroom.

Class Scheduling: (used in interviews) The teacher describes his or her class schedule and any changes that have been made to that schedule throughout the semester.

Classroom environment: (used in interviews) The teacher mentions that the classroom environment is an important part of learning. The environment includes both the

physical environment and the social/emotional environment.

Classroom management: (used in interviews) The teacher discusses strategies for behavior management in their classrooms.

Classroom Technology: (used in interviews and class observations) The teacher describes ways that technology is used in their classrooms or technology use is observed in the classroom. The types of technology mentioned include: blogs, calculators, CD Players, computers, educational software, educational websites, Elmo projector, Leap Frog, the Internet, and Smartboards.

Collaborative learning: (used in interviews and class observations): Teacher describes a learning activity in which the children work together, or the children were observed working together on an assignment.

Critical thinking: (used in interviews) The teacher states the importance of critical thinking and/or describes ways in which they promote critical thinking in their students.

Differentiation: (used in interviews) The teacher explains how he or she meets the needs of students with differing levels of readiness and ability. This could be done with or without the use of technology.

Direct instruction: (used in interviews and class observations): Teacher describes a teaching students through a didactic approach where the teacher tells the students the information, or the teacher is observed giving a lecture or mini-lecture.

Effects of school on classroom: (used in interviews): Teacher describes how the school environment, resources, and policies affect their teaching decisions and decisions about technology.

Email: (used in interviews): Teacher explains his or her views on email as one of the primary forms of communication between teachers and administrators at the school.

Facilitator: (used in interviews): Teacher describes him or herself as a "facilitator" and explains what that means in their classroom.

Good professional development: (used in interviews) Teachers give examples of good professional development and describe the qualities of that professional development.

Grading: (used in interviews) The teacher explains methods for grading or talks about the pressures of grading.

Ideal student: (used in interviews) The teacher describes the qualities of an ideal student.

Lesson cycle: (used in interviews) The teacher explains the cycle and how they use one or more steps in their classrooms. These steps include: Direct Instruction, Guided Practice, Independent Practice and Assessment/ Feedback.

LSPD compared to other PD: (used in interviews) The teacher compares the technology-infused lesson study professional development to any other type of professional development.

Math: (Used in interviews and class observations) Math is the subject being taught or discussed.

Meeting Topics: (used for meeting transcripts) This group of codes deals with all topics covered in the PLC meetings including: changes, chapter book, collaboration, common assessment, critical thinking, email, end of semester, grading, homework for break, inferencing, lesson study, Math, maximizing class time, Montessori, needed materials, objectives, paperwork, personal issues, professional development, reading level testing, school budget, school functions, science, sharing materials/ ideas, standardized tests, student issues, teacher evaluations, technology, writing, and field trips.

Meeting leader: (used for meeting transcripts) This code was used to mark the person who was leading that particular meetings. Usually this person had the meeting agenda and dominated the converstion.

Meeting mood: (used for interviews and meeting transcripts) This code was used when a teacher made a comment during or after a meeting about their mood or the mood of others in the meeting. Both positive and negative emotions were coded.

Metacognitive: (used in interviews) The teacher discusses the importance of metacognitive skills and/or describes how they teach their students metacognitive skills.

Montessori: (used in interviews and class observations) This code was used when the teacher talked about the importance or differences related to Montessori education. Teachers also described the Montessori paradigm as they understood it. The code was also used in observations of Montessori classes.

Personal technology: (used in interviews) The teacher describes the personal technology that he or she uses.

Observe colleague: (used in interviews) The teacher describes the pros and cons of

observing a colleague.

Professional development: (used in interviews) The teachers listed and described all of the professional development they attended during the school year of the study.

Reasons for not using technology: (used in interviews) The teacher explains why they do not use technology in the classroom. Reasons include: not enough computers, not enough time, and not enough support personnel.

Reason for Technology: (used in interviews) The teacher describes the ways they use technology and their reasons for that use. The reasons include: efficiency, as a reward, as a station, as a time saver, to educate students for the changing society, and for research.

Role playing: (used in interviews and class observations) The teacher either used or described a lesson in which students were role playing.

Science: (Used in interviews and class observations) Science is the subject being taught or discussed.

Student motivation: (used in interviews) The teacher explains the importance of student motivation and/or describes ways that they motivate their students. Examples of this may or may not include technology.

Teacher assistant: (used in interviews and class observations) The teacher describes the ways that they use their assistant, or an assistant is observed in the classroom.

Teacher Collaboration: (used in interviews) The teacher describes the pros and cons of sharing ideas and materials with other teachers.

Teacher experience: (used in interviews) The teacher recounts their teaching experience including: positions held, duration, and education degrees.

Teacher learning: (used in interviews) The teacher relates an example of something the he or she has learned and/ or the way in which he or she learns within the teaching profession.

Teacher emotions: (used in interviews) The teacher described a positive or negative emotion that he or she was feeling or had felt during the semester.

Technology Balance: (used in interviews) The teacher described a need for there to be a balance between technology and face-to-face instruction in the classroom.

Technology Efficacy: (used in interviews) The teacher talks about their comfort level in using technology, both personally and in the classroom.

Tutoring: (used in interviews) The teacher expressed the need for tutoring, the importance of tutoring, or an intent to begin tutoring his or her students.

Wanted resources: (used in interviews) The teacher expresses a desire for a specific resource. These included: textbooks, Montessori teaching materials, computers, and access to software programs.

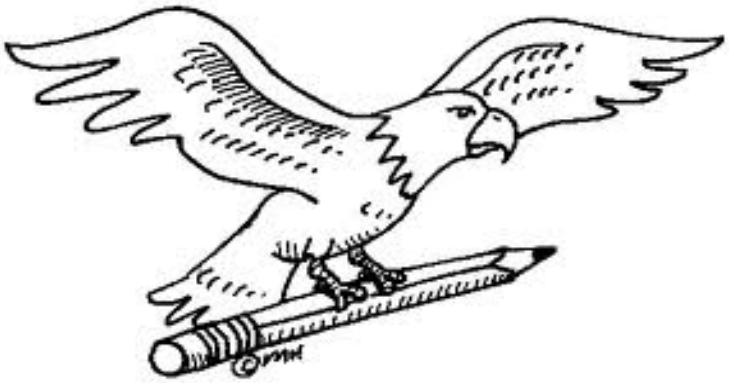
Writing: (used in interviews and class observations) Writing is the subject being taught or discussed.

Appendix F: Tentative Timeline

Dates	Professional Development Activity	Data Collected	Participants
Aug. 15-Aug. 19	Lesson Study Introduction	Pre-surveys and interviews	Whole school
Aug. 15-Aug. 19	Teacher Facilitator Training	Post-training surveys	Teacher Facilitators
Aug. 22- Sept. 2	Phase I – Grade Level Meeting 1	Audiotapes of the meeting Observation notes	Volunteer grade levels
Sept. 5-Sept. 9	Phase I – Grade Level Meeting 2	Audiotapes of the meeting Observation notes Lesson Plan Guide	Volunteer grade levels
Sept. 12- Sept. 23	Phase I- Observation Lesson	Teacher Observations Researcher Observations	Volunteer grade levels
Sept. 12- Sept. 23 (1-2days after observation)	Phase I- Grade Level Meeting 3	Audiotapes of the meeting Observation notes Revised Lesson Plan	Volunteer grade levels
Sept. 26- Sept. 30	OPTIONAL- Lesson Revision and Observation	Audiotapes of the meeting Observation notes Revised Lesson Plan	Volunteer grade levels
Sept. 26- Oct. 7	Phase I- Individual Lesson Implementation	Researcher observation notes	Volunteer grade levels- individual
Oct. 10- Oct. 14	Phase I- Grade Level Meeting 4	Audiotapes of the meeting Observation notes Reflective Lesson Write-up	Volunteer grade levels
Oct. 10- Oct. 14	Phase I-Post Interviews	Audiotape of interviews	Volunteer grade levels- individual
Oct. 17- Oct. 21	Teacher Facilitator Training	Post-training surveys	Teacher Facilitators
Oct. 24- Oct. 28	Phase II – Grade Level Meeting 1	Audiotapes of the meeting Observation notes	Whole School
Oct. 31-Nov. 11	Phase II – Grade Level Meeting 2	Audiotapes of the meeting Observation notes Lesson Plan Guide	Whole School
Nov. 14-Nov. 22	Phase II- Observation Lesson	Teacher Observations Researcher Observations	Whole School
Nov. 14-Nov. 22 (1-2 days after observation)	Phase II- Grade Level Meeting 3	Audiotapes of the meeting Observation notes Revised Lesson Plan	Whole School
Nov. 28-Dec. 2	OPTIONAL- Lesson Revision and Observation	Audiotapes of the meeting Observation notes Revised Lesson Plan	Whole School
Nov. 28- Dec. 9	Phase II- Individual Lesson Implementation	Researcher observation notes	Whole School – individual
Dec. 12- Dec. 16	Phase II- Grade Level Meeting 4	Audiotapes of the meeting Observation notes Reflective Lesson Write-up	Whole School
Dec. 12- Dec. 30	Post Interviews and Surveys	Pre-surveys and interviews	Whole School- individual

Appendix G: Lesson Study Facilitator Guide

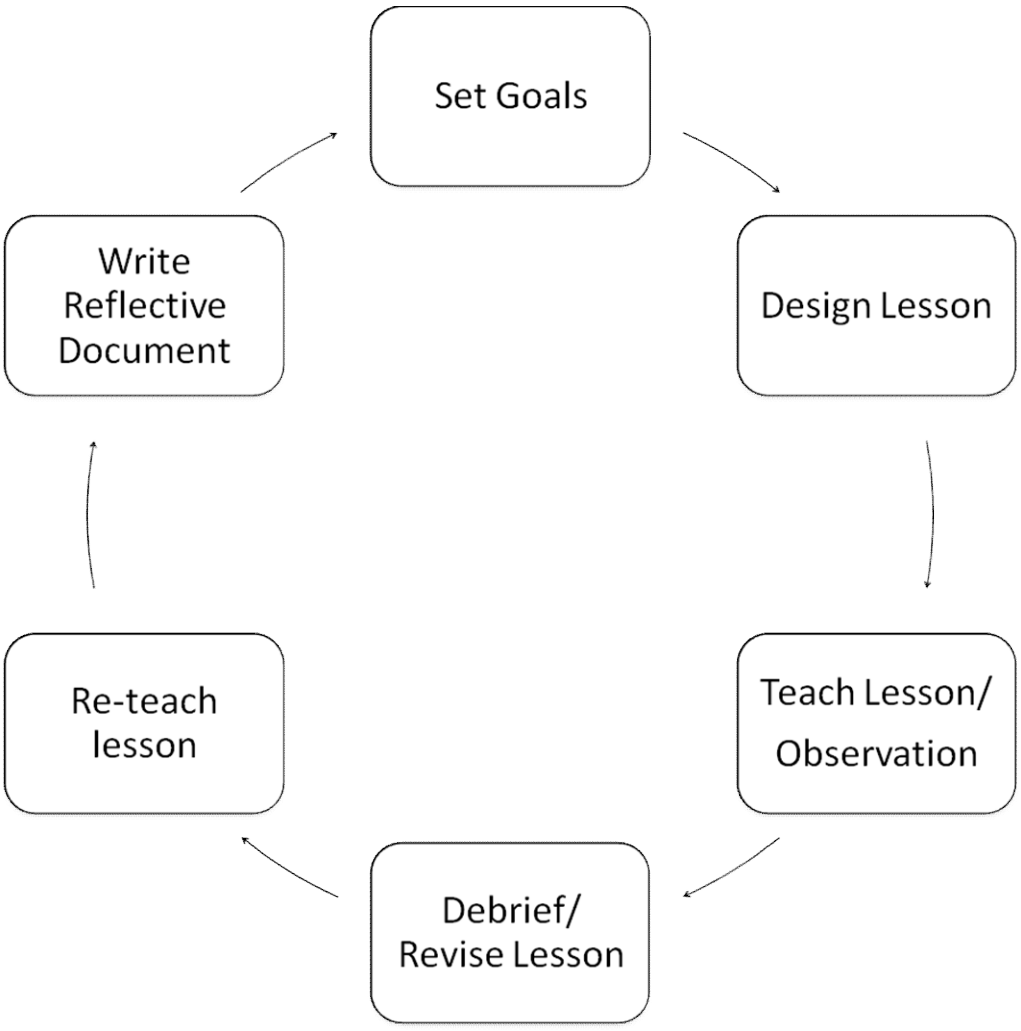
Lesson Study



Facilitator's guide

What is Lesson Study?

Lesson Study is a professional development technique that originated in Japan. In the lesson study process, teachers work collaboratively to create, implement, revise, and reflect on a specific lesson or objective that needs to be taught. The lesson study provides teachers with differing levels of knowledge and experience to learn from one another through modeling and dialogue. The final step in the lesson study process involves writing a reflective report documenting the lesson, the materials used, and insights into what the group learned through the process.



Meeting 1: Choose Objectives

During the first meeting teachers will set group norms and decide on a specific learning objective or group of related objectives for their group lesson. The learning objective should be one that past students have found difficult to master or that current students are struggling to grasp. The group must come to consensus about the learning objective or objectives. These decisions should be based on past or present student grades, test scores, benchmark scores, informal assignments, or teacher observations.

Goals:

- Decide as group what subject to use for the research lesson.
- Choose an objective (or group of objectives) to teach in teach research lesson.
- Schedule group all other group meetings.

Tip: Remember to consider when you will be teaching the research lesson when choosing objectives. This will help your team choose an objective that is appropriate within the scope and sequence of your lesson plans.

Subject:

_____

Objective(s):

_____

_____

☐ We scheduled our other group meetings.

Before the next meeting:

- Think about how you taught those objectives in the past.
- Think about ways you can incorporate technology to teach these objectives.

Meeting 2: Designing the Lesson

The second group meeting focuses on designing the lesson. Teachers work as a team to plan a lesson based on the previously chosen objectives. This lesson should include technology in some way. Use the lesson planning guide on the next page to guide your discussion and planning of the research lesson. After the lesson has been planned, choose one teacher to teach the lesson as a model and assign all other group members observation roles. These roles should focus on different aspects of the lesson and the student learning (i.e., student questions, timing of activities, student interactions). The purpose of the observation is to critique the team-created lesson and its impact on students' learning, not the individual skills of a teacher.

Goals:

- Plan a research lesson.
- Choose a teacher and time for the model research lesson.
- Assign observation roles to each of the teachers.

Tip: Tell the principal as soon as you have scheduled the model lesson. The earlier this is scheduled, the easier it will be to arrange substitutes for your class.

☐ We have completed the lesson plan template.

☐ Our lesson includes technology.

☐ Each person has been assigned a role for the observation.

Before the next meeting:

- Be sure to take good notes during the observation so you can share them with your team.
- After the observation, think about ways the lesson could be improved.

Lesson Plan Guide

Goal of the Lesson:			
TEKS:			
Technology :			
Purpose for Technology:			
Steps of Lesson	**Expected Student Responses**	**Rationale/ Responses to Students**	**Assessment**

Model Lesson/ Observation

This portion of the lesson study cycle occurs in the classroom of one group member. That teacher implements the lesson plan with their students while all other teachers observe. Each observer should have a specific role. None of these roles should focus directly on the teacher actions, but rather should concentrate on the students and their behaviors throughout the lesson.

Goals:

- Teach the lesson with actual students.
- Observe the lesson using a student-focused approach.

Tip: Selecting specific roles prior to the observation will help each teach focus closely on one aspect of the lesson.

Suggested Observation Roles:

- Student Questions
  - One person can write down every time a student asks or answers a question.
- Student Groups
  - If the students are in groups, each team member can be responsible for observing one group of students.
- Student Engagement
  - This person monitors when the students are most and least engaged. Write down what makes you think that they are engaged/ unengaged at various times during the lesson.
- Time Keeper
  - This person keeps track of long students take to complete each part of the lesson.
- Other
  - As a team, choose other areas specific to your lesson plan.

Before the next meeting:

- Review your observation notes.
- Think about ways the lesson could be improved.

Meeting 3: Debrief/Revise the Lesson

This meeting should occur within one to two days of the observation lesson. The teacher who modeled the lesson starts by sharing his or her thoughts about the lesson. Then each of the other teachers takes turn sharing their observation notes. Any student work or class assessments produced during the lesson should also be reviewed during this meeting. As a group teachers tweak the original lesson based on this information. If the lesson did not go well, they can choose to completely revise the lesson and conduct another observation lesson in a new teacher's class. If the lesson needs only minor revisions, the teachers can make those changes and teach the lesson in their own classrooms.

Goals:

- Review the observation feedback and student work.
- Make revisions to the original lesson plan.
- All teachers prepare to teach the lesson.

Tip: Remember that this meeting is about the group planned lesson, not an individual instructor's teaching style. Keep the focus of the meeting on the lesson components and the student learning.

Revisions:

_____

_____

_____

Reason for changes:

_____

_____

Before the next meeting:

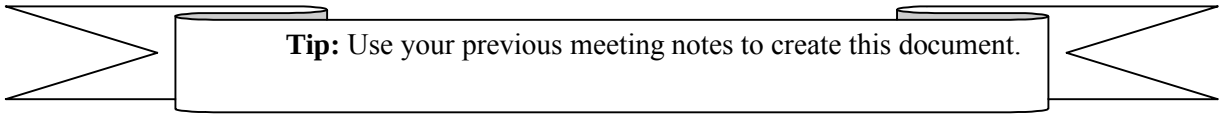
- Each group member should teach the lesson in his or her class.
- Reflect on the lesson and what you learned through the lesson study process.

Meeting 4: Write Reflective Report

The final stage of the lesson study process is to create a reflective document to share with others. This report should tell the story of your group's process with lesson study and include the final lesson that you have created. This report will be kept in a shared space so that other teachers will be able to view your lesson. You will also be able to view their reports.

Goals:

- Reflect on your experiences with lesson study.
- Create a report to share with the other teachers at your school.



Things to include:

- Learning Objectives
  - Include the objectives and you reasons for choosing that objective.
- Lesson Plan (first draft)
  - Include the first draft of the lesson plan. Add a short paragraph about how your group chose those activities.
- Observations
  - Include a brief description of what was learned in the observations.
- Lesson Plan (final)
  - Include the final draft of the lesson. Also describe why the revisions were made to the lesson.
- Individual Reflection
  - Include a short paragraph from each teacher about their experience in the lesson study.
- Group Reflection
  - Write a brief description of any discussions, challenges, or concerns that you faced as a group. Also discuss any strategies that helped you function as a group.

References

Angeli, C., & Valanides, N. (2005). Preservice teachers as ICT designers: An instructional design model based on an expanded view of pedagogical content knowledge. *Journal of Computer-Assisted Learning*, 21(4), 292–302.

Angeli, C. & Valanides, N.(2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education,* 52, 154-168.

Angrist, J. D. & Lavy, V.(2001). Does teacher training affect pupil learning? Evidence from matched comparisons in Jerusalem public schools. *Journal of Labor Economics*, 19(2), 343-369.

Archambault, L. & Crippen, K.(2009). Examining TPACK among k-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, 9(1). Retrieved from http://www. citejournal. org/vol9/iss1/general/article2. cfm

Atkinson, J. W.(1957). Motivational determinants of risk taking behavior. *Psychological Review, 64,* 359-372.

Atkinson, R. C & Shiffrin, R. M.(1968). Human memory: A proposed system and its control process. In Spence, K. W. & Spence, J. T.(Eds.), *The psychology of learning and motivation, Volume II* (pp. 90-191). New York, NY: Academic Press, Inc.

Avalos, B.(2011). Teacher professional development in *Teaching and Teacher Education* over ten years. *Teaching and Teacher Education, 27,* 10-20.

Bandura, A.(1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Becker, H. J., Anderson, R. E.(1998). *Teaching, learning, and computing: 1998*: *A national survey of schools and teachers describing their best practices, teaching philosophies, and use of technology.* Research funded by the National Science Foundation and the Office of Educational Research and Improvement, U. S. Department of Education.

Birman,B. F., Desimone, L., Porter A. C. & Garet,M. S.(2011). Designing professional development that works. *Educational Leadership,* 28-33.

Bonk, C. J. & Cunningham, D. J.(1998). Searching for learner-centered, constructivist, and socio-cultural components of collaborative educational learning tools. In C. J. Bonk & K. S. King (Eds.) *Electronic collaborators: Learner-centered technologies for literacy, apprenticeship, and discourse.(*pp. 25-50). Mahwah, NJ: Erlbaum.

Borko, H.(2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher,* 33(8), 3-15.

Boyd, V., & Hord, S. M.(1994). Schools as learning communities. *Issues About Change, 4(1).*

Brinkerhoff, J. D., Ku, H. Y., Glazewski, K., Brush, T.(2001). An assessment of technology skills and classroom technology integration experience in preservice and practicing teachers. Presentation at the meeting of the Association for Educational Communications and Technology, Atlanta, GA.

Brinkerhoff, J.(2006). Effects of a long-duration, professional development academy on technology skills, computer self-efficacy, and technology integration beliefs and practices. *Journal of Research on Technology in Education*, *39*(1), 22-43.

Brush, T., Glazewski, K., Rutowski, K., Berg, K., Stromfors, C., Van-Nest, M. H., Stock, L. & Sutton, J.(2003). Integrating technology in a field-based teacher training program: The PT3@ASU Project. *Educational Technology Research & Development*, 51(1), 57-72.

Calderhead, J.(1996). Teachers: Beliefs and knowledge. In D. Berliner, &R. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 709-725). New York: Macmillan Library Reference.

Calvin, R.(2008). Developing technological pedagogical content knowledge in preservice teachers through microteaching lesson study (doctoral dissertation). Retrieved from Proquest Dissertations and Theses.(3301531)

Cassidy, S & Eachus, P.(2002). Developing the computer user self-efficacy (CUSE) scale: Investigating the relationship between computer efficacy, gender, and experience. *Journal of Educational Computing Research,* 26(2), 133-153.

Chai, C. S., Koh, J. H. L., & Tsai, C. -C.(2010). Facilitating Preservice Teachers' Development of Technological, Pedagogical, and Content Knowledge (TPACK). *Educational Technology & Society*, *13* (4), 63–73.

Chokshi, S. & Fernandez, C. (2005). Reaping the benefits of lesson study: Insights for the U.S. *Phi Delta Kappan*, 86(9) 674-680.

Choy, S. P., Chen, X. & Bugarin, R.(2006). Teacher professional development in 1999-2000: What teachers, principals, and district staff report (NCES 2006-305). U. S. Department of Education: Washington, D. C., National Center for Education Statistics.

Clausen, K. W., Aquino, A. & Wideman, R.(2009). Bridging the real and ideal: A comparison between learning community characteristics and a school-based case study. *Teaching and Teacher Education,* 25(3), 444-452.

Cooper, C., & Boyd, J.(1994). *Collaborative approaches to professional learning and reflection*. Launceston: Global Learning Communities.

Corbin, J. & Strauss, A.(2008). *Basics of Qualitative Research* (3rd Ed.). United States of America: Sage Publications, Inc.

Corcoran, T. B., Furhman, S. H. & Belcher, C. L.(2001). The district role in instructional improvement. *Phi Delta Kappan,* 83(1), 78-84.

Cotton, K.(2004). *New small learning communities: Findings from recent literature*. Portland, OR: Northwest Regional Educational Laboratory.

Cuban, L.(1986). *Teachers and machines: The classroom use of technology since 1920*. New York: Teachers College Press.

Cuban, L., Kirkpatrick, H., & Peck, C.(2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal, 38(4),* 813-834.

Da Ponte, J. P, Oliveira, H. & Varandas, J. M.(2002). Development of pre-service mathematics teachers' professional knowledge and identity in working with information and communication technology. *Journal of Mathematics Teacher Education,* 5, 93-115.

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S. & Birman, B. F.(2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis,* 24(2), 81-112.

Elmore, R. (2004). The hollow core of leadership in practice. Unpublished paper. Cambridge, MA: Havard University Graduate School of Education.

Ertmer, P. A.(1999). Addressing first- and second-order barriers to change. Strategies for technology implementation. *Educational Technology Research and Development, 47(4),* 47–61.

Ertmer, P. A.(2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development, 53*(4), 25–39.

Eteokleous, N. (2008). Evaluating computer technology integration in a centralized educational system. *Computers in Education Journal, 51 (2), 669-686.*

Fang, Z. (1996). A review of research on teacher beliefs and practices. *Educational Research, 38* (1), 47-65.

Faryardi, Q.(2007). The Montessori paradigm of learning: So what? Retrieved June 26, 2011. http://peoplelearn. homestead. com/MEdHOME2/EarlyChildhood/MariaMontessori. Malaysia. pdf

Fernandez, C.(2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education, 53(5).* 393-405.

Fernandez, C., Cannon, J. & Chokshi, S. (2003). A US–Japan lesson study collaboration reveals critical lenses for examining practice. *Teacher and Teacher Education,* 19, 171–185.

Fredig, R. E.(2006). Assessing technologies for teaching and learning: Understanding the importance of technological pedagogical content knowledge. *British Journal of Education Technology*, 37(5), 749-760.

Fullan, M.(1993). *Change forces: Probing the depths of educational reform*. London: The Falmer Press.

Fullan, M.(2007). *The new meaning of educational change* (4th ed.) New York, NY: Teachers College Press.

Fullan, M., & Hargreaves, A.(1991). *Working together for your school. What's worth fighting for?* Hawthorn: ACEA.

Gibson, S. & Dembo, M. H.(1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology,* 76(4), 569-582.

Girod, M., Bell, J., Mishra, P.(2007). Using digital video to re-think teaching practices. *Journal of Computing in Teacher Education, 24,* 23- 29.

Graham, Charles R. (2011). Theoretical considerations for undertaking technological pedagogical content knowledge (TPACK). *Computers & Education, 57 (3),* 1953-1960.

Grandgenett, N., Harris, J., & Hofer, M.(2011, February). *Mathematics learning activity types*. Retrieved from College of William and Mary, School of Education, Learning Activity Types Wiki: http://activitytypes. wmwikis. net/file/view/MathLearningATs-Feb09. pdf

Grasha, A. F. & Yangarber-Hicks, N.(2000). Integrating teaching styles and learning styles with instructional technology. *College Teaching,* 48(1), 2-10.

Gray, L., Thomas, N., Lewis, L., & Tice, P.(2009). *Teacher's use of educational technology in U. S. public schools: 2009 first look*.(NCES 2010-040). National Center for Educational Statistics, Institute of Educational Sciences, U. S. Department of Education. Washington, DC.

Graves, L. N.(1992). Cooperative learning communities: context for a new vision of education and society. *Journal of Education*, 174(2), 57–79.

Greeno, J. G.(2003). Situative research relevant to standards for school mathematics. In J. Kilpatrick, W. G. Martin, and D. Schifter (Eds.), *A research companion to principles and standards for school mathematics* (pp. 304–332). Reston, VA: National Council of Teachers of Mathematics.

Groth, R., Spickler, D., Bergner, J., Bardzell, M.(2009). A qualitative approach to assessing technological pedagogical content knowledge. *Contemporary Issues in Technology and Teacher Education, 9(4)*, 392-411.

Guba (1981). Criteria for assessing the trustworthiness of naturalistic inquiry. *Educational Communication and Technology Journal, 29(2),* 75-91.

Guskey, T. R.(2002). Professional development and teacher change. *Teachers and Teaching: theory and practice,8(3/4), No. 3/4,* 381-391.

Guskey, T. R. & Yoon, K. S.(2009). What works in professional development?. *Phi Delta Kappan* 90(7), 495-500.

Harris, J.(2005). Our agenda for technology integration: It's time to choose. C*ontemporary Issues in Technology and Teacher Education, 5*(2), 116 -122.

Harris, J. B.(2008). TPACK in inservice education: Assisting experienced teachers' planned improvisions. In AACTE Committee on Innovation & Technology (Eds.), *Handbook of technological pedagogical content knowledge for educators* (pp. 251-271). New York: Routledge.

Harris, J., Grandgenett, N., & Hofer, M.(2010). Testing a TPACK-based technology integration assessment instrument. In Maddux, C.(Ed.). *Research highlights in technology and teacher education 2010* (pp. in press). Chesapeake, VA: AACE.

Harris, J., & Hofer, M.(2009). Instructional planning activity types as vehicles for curriculum-based TPACK development. In C. D. Maddux, (Ed.). *Research highlights in technology and teacher education 2009* (pp. 99-108). Chesapeake, VA: Society for Information Technology in Teacher Education (SITE).

Harris, J., & Hofer, M.(2011). Technological pedagogical content knowledge (TPACK) in action: A descriptive study of secondary teacher's cuuriculum-based, technology-related instructional planning. *Journal of Research in Teacher Education, 43(3), 211-229.*

Harris, J. B., Hofer, M. J., Schmidt, D. A., Blanchard, M. R., Young, C. Y., Grandgenett,N. F. & van Olphen, M.(2010). "Grounded" technology integration: Instructional planning using curriculum-based activity type taxonomies. *Journal of Technology and Teacher Education, 18(4),* 573-605.

Harris, J., Mishra, P., Koehler, M.(2009). Teacher's technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of Research on Technology in Education,* 41(4), 393-416.

Hatch, T. (2000). *What happens when multiple improvement initiatives collide*. Menlo Park, CA: Carnegie Foundation for the Advancement of Teaching.

Hervey, L.(2009). Lost and Found In Translation: A TPCK View of Mid-Career Teacher Beliefs and Practice. In I. Gibson et al.(Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2009* (pp. 4096-4098). Chesapeake, VA: AACE.

Hew, K. F. & Brush, T.(2006). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Education Technology Research and Development,*55, 223–252.

Holcomb, L. B, King, F. B., Brown, S. W.(2004). Student traits and attributes contributing to success in online courses: Evaluation of university online courses. *The Journal of Interactive Online Learning, 2(3),* 1-17.

Hubbell, E. R.(2006). Authenticity and technology in Montessori education. *Montessori Life, 18(2)*, 16-20.

Hughes, J. E.(2005). The role of teacher knowledge and learning experiences in forming technology integrated pedagogy. *Journal of Technology and Teacher Education,*13 (2), 377-402.

Hughes, J.E., Guion, J. M., Bruce, K. A., Horton, L. R., & Prescott, A. (2011.) A framework for action: Intervening to increase adoption of transformative web 2.0 learning resources. *Educational Technology, 51*(2), 53-61.

Hughes, J. E., Kerr, S. P., Ooms, A.(2005). Content-focused technology inquiry groups: Cases of teacher learning and technology integration. *Journal of Educational Computing Research, 32(4)*, 367-379.

Hunter, M. (1967). *Teach More–Faster!* El Segundo, CA: TIP Publications

Hunzicker, J.(2010). Effective professional development for teachers: A checklist. *Professional Development in Education, 37(2),*177-179.

ISTE.(2007). *National educational technology standards for students (NETS-S)*. Eugene, OR: International Society for Technology in Education.

ISTE.(2008). *National educational technology standards for teachers (NETS-T)*. Eugene, OR: International Society for Technology in Education.

ISTE.(2009). *National educational technology standards for administrators (NETS-A).* Eugene, OR: International Society for Technology in Education.

Jacob, B. A. & Lefgren, L.(2004). The impact of teacher training on student achievement: Quasi-experimental evidence from school reform efforts in Chicago. *The Journal of Human Resources,* 39(1), 50-79.

Kagan, D. M.(1992). Implications of research on teacher belief. *Educational Psychologist, 27*(1), 65–90.

Knapp, L.(1996). *Restructuring schools with technology.* Boston: Allyn & Bacon.

Koehler, M. J. & Mishra, P.(2005a). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research*, 32(2), 131-152.

Koehler, M. J. & Mishra, P.(2005b). Teachers learning technology by design. *Journal of Computing in Teacher Education*, 21(3), 94-102.

Koehler, M. J., Mishra, P. & Yahya, K.(2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy, and technology. *Computers & Education,* 49, 740-762.

Lave, J. & Wegner, E.(1991). *Situated learning: legitimate peripheral participation.* New York: Cambridge University Press.

Lawless, K. A. and J. W. Pelligrino (2007). "Professional development in integration technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers." Review of Educational Research **77**(4): 575-614.

Lee, H. & Hollebrands, K.(2008). Preparing teachers to teach mathematics with technology: An integrated approach to developing technological pedagogical content knowledge. *Contemporary Issues in Technology and Teacher Research,* 8(4), 326-341.

Lee, M. H. & Tsai, C. C.(2008) Exploring teachers' perceived self efficacy and technological pedagogical content knowledge with respect to educational use of the world wide web. *Instructional Science,* 38(1), 1-21.

Leithwood, K. (2005). *Teacher working conditions that matter.* Toronto: Elementary Teachers Federation of Ontario.

Levin, T. & Wadmany, R.(2005). Changes in educational beliefs and classroom practices of teachers and students in rich technology-based classrooms. *Technology, Pedagogy, and Education*, 14(3), 281-308.

Lewis, C.(2002). Does lesson study have a future in the United States? *Nagoya journal of education and human development,* 1, 1-23.

Lewis, C.(2009). What is the nature of knowledge development in lesson study? *Educational Action Research*, 17(1), 95-110.

Lilliard, A.(2008). How important are the Montessori materials? *Montessori Life, 20(4),* 20-25.

Lincoln, Y. S., & Guba, E. G.(1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.

Love, A. & Sikorski, P.(2000). *Integrating Technology in a Montessori Classroom.*

Macmillan, R., Liu, X., &Timmons, V.(1997). Teachers, computers, and the Internet: The first stage of a community-initiated project for the integration of technology into the curriculum. *The Alberta Journal of Educational Research*, 53(4), 222-234.

Margerum-Lays, J. & Marx, R. W.(2003). Teacher knowledge of educational technology. In Zhao, Y.(Ed.), *What should teachers know about technology? Perspectives & Practices.(*p123-159). Greenwich, Connecticut: Information Age Publishing.

Mayer, R. H.(1999). Designing instruction for constructivist learning. In Reigeluth, C. M.(Ed.), *Instructional-design theories and models: A new paradigm of instructional theory, Volume II.(*pp. 141-160). Mahwah, NJ: Lawrence Erlbaum Associates.

McCannon, M., & Crews, T.(2000). Assessing the technology training needs of elementary school teachers. *Journal of Technology and Teacher Education, 8*(2),111–121.

Mishra, P. & Koehler, M. J.(2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research,* 32(2), 131-152.

Mishra, P. & Koehler, M. J.(2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108 (6), 1017-1054.

Montessori, M.(1989). *To educate the human potential.* Oxford, England: Clio Press.

Montessori, M.(1912). *The Montessori Method.* New York, NY: Frederick Stokes Co.

Monson, M.(006). Reconstructing Montessori: On being an authentic Montessori school. *Montessori Life, 18(2),*36-43.

Mouza, C. & Wong, W.(2009) Studying classroom practice: Case development for professional learning in technology integration. *Journal of Technology and Teacher Education, 17(2),* 175-202.

Niess, M. L.(2005). Preparing teachers to teach science and mathematics with technology: Developing a technological pedagogical content knowledge. *Teachers and Teacher Education,* 21,509-523.

Niess, M. L.(2006). Guest editorial: Preparing teachers to teach mathematics with technology. *Contemporary Issues in Technology and Teacher Education,* 6(2), 195-203.

Niess, M. L., Ronau, R. N., Shafer, K. G. Driskell, S. O., Harper, S. R., Johnston, C., Browning, C., Oz-gun-Koca, S. A. & Kersaint, G.(2009). Mathematics teacher TPACK standards and development model. *Contemporary Issues in Technology and Teacher Education,* 9(1), 4-24.

Partnership for 21st Century Skills.(2009, December). *P21 framework definitions*. Tucson, AZ: Partnership for 21st Century Skills. Available: http://www. p21. org/documents/P21_Framework_Definitions. pdf

Pierce, R. & Stacey, K.(2009). Researching principles of lesson design to realize the pedagogical opportunities of mathematics analysis software. *Teaching Mathematics and Its Applications, 28*, 228-233.

Pierson, M. E.(2001). Technology integration practices as a function of pedagogical expertise. *Journal of Research on Computing in Education. 33(*4), 413-429.

Prieto, L. P., Villagrá-Sobrino, S., Jorrín-Abellán, I. M., Martínez-Monés, A. & Dimitriadis, Y.(2011). Recurrent routines: Analyzing and supporting orchestration in technology enhanced primary classrooms. *Computers and Education. 57,* 1214–1227.

Puchner, L.D. & Taylor, A. R. (2006). Lesson study, collaboration and teacher efficacy: Stories from two school-based math lesson study groups. *Teaching and Teacher Education,* 22, 922–934.

Putnam, R. T. & Borko, H.(2000). What do knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29(1),* 4-15.

Ravitz, J. L., Becker, H. J, Wong, Y. T.(2000). Constructivist-compatible beliefs and practices among U. S. teachers. Teaching, learning, and computing: 1998 National Survey (Report # 4). Center for research on information technology and organizations. University of California, Irvine and University of Minnesota.

Read, M. F., Jones, S. J., Hughes J.E., Gonzales-Dholakia, G. (2011, April). An ecological case study of two middle schools' technology integration. *Paper session presented at the Annual Meeting of the American Educational Research Association*, New Orleans, LA.

Richardson, S.(2000). Mathematics teachers' development, exploration, and advancements of technological pedagogical content knowledge in the teaching and learning of algebra. *Contemporary Issues in Technology and Teacher Education,* 9(2), 117-130.

Rogers, E. M.(2003). *Diffusion of innovations* (5th ed.). New York, NY: Simon & Schuster, Inc.

Roschelle, J.(1992). Learning by collaborating: Convergent conceptual change: *Journal of the Learning Sciences,* 2 (3), 235-276.

Ruby, J.(1980). Exposing yourself: Reflexivity, anthropology, and film. *Semiotica, 30,* 153-179.

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K.(2003). Examining teacher technology use: Implications for preservice and inservice teacher preparation. *Journal of Teacher Education,* 54(4), 297-310.

Saldana, J. Leavy, P. & Beretvas, N, (2011). *Fundamentals of Qualitative Research.* Oxford University Press: USA.

Sandholtz, J. H., Ringstaff, C. & Dwyer, D. C.(1997). *Teaching with technology: Creating student-centered classrooms.* New York: Teachers College Press.

Sang, G., Valcke, M., van Braak, J., Tondeur, J.(2010). Student teachers' thinking processes and ICT intergration: Predictors of prospective teaching behaviors with educational technology. *Computers and Education, 54,* 109-112.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J. & Shin, T. S.(2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research in Teacher Education,* 42(2), 123-149.

Shulman, S. S.(1986). Those who understand: Knowledge growth in teaching. *Educational Researcher,* 15(2), 4-14.

Schunk, D. H. & Zimmerman, B. J.(2007). Influencing children's self-efficacy and self-regulation of reading and writing through modeling. *Reading & Writing Quarterly,* 23, 7-25.

Slepkov, H.(2008). Teacher professional growth in an authentic learning environment. *Journal of Research on Technology in Education,* International Society for Technology in Education. 41, 85-111.

Smylie, M. A.(1989). Teachers' views of the effectiveness of sources of learning to teach. *The Elementary School Journal,* 89(5), 543-558.

So, H. J, & Kim, B.(2009). Learning about problem based learning: Student teachers integrating technology, pedagogy, and content knowledge. *Australian Journal of Educational Technology,* 25(1), 101-116.

Stigler, J. & Hiebert, J.(1999). *The teaching gap.* New York: Summit.

Tee, M. Y. & Lee, S. S.(2011). From socailisation to internatisation: Cultivating tehnological pedagogical content knowledge through problem-based learning. *Australasian Journal of Educational Technology, 27(1)*, 89-104.

Tschannen-Moran, M., Woolfolk Hoy, A. & Hoy, W. K.(1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research,* 68(2), 202- 248.

Tubin, D., & Edri, S.(2004). Teachers planning and implementing ICT-based practices. *Planning and Changing,* 35 (3&4), 181- 191.

Tudge, J. R. H.(1992). Processes and consequences of peer collaboration: a Vygotskian analysis. *Child Development,* 63, 1364-1379.

U. S Department of Education.(2010). *Transforming American education: Learning powered by technology* (National Educational Technology Plan). Washington, DC: Office of Educational Technology (OET). Available: http://www. ed. gov/sites/default/files/NETP-2010-final-report. pdf

Valanides, N., & Angeli, C.(2006). Preparing preservice elementary teachers to teach science through computer models. *Contemporary Issues in Technology and Teacher Education - Science*, 6(1), 87–98.

Valanides, N., & Angeli, C.(2008a). Learning and teaching about scientific models with a computer modeling tool. Computers in Human Behavior, 24, 220–233.

Valanides, N., & Angeli, C.(2008b). Professional development for computer-enhanced learning: A case study with science teachers. *Research in Science and Technological Education*, 26(1), 3–12.

Vygotsky, L. S.(1978), *Mind in Society*. Cambridge, MA: Harvard University Press.

Watanabe, T. (2002). Learning for Japanese lesson study. *Educational Leadership,* 59 (6), 36-39.

Wertsch, J. V.(1991). A sociocultural approach to socially shared cognition. In Resnick, L. B., Levine, J. M., & Teasley, S. D.(Eds.), *Perspectives on socially shared cognition,* pp. 85-100. Washington, DC: American Psychological Association.

Whisenhunt, T. G.(2009). The impact of interdisciplinary lesson study on teacher's instructional decisions and technology use, (doctoral dissertation). Retrieved from Proquest Dissertations and Theses. University of Oklahoma.

Windschitl, M. & Sahl, K.(2002). Tracing teachers' use of technology in a laptop computer school. The interplay of teacher beliefs, social dynamics, and institutional culture. *American Educational Research Journal*, 39(1), 165-205.

Yildirm, S.(2000). Effects of an educational computing course on preservice and inservice teachers: A discussion and analysis of attitudes and use. *Journal of Research on Computing in Education,* 32(4), 479–495.

Yin, R.K.(2009).*Case Study Research: Design and methods* (4th).Thousand Oaks, California: Sage Publications, Inc.

Yinger, R.(1979). Routines in teacher planning. *Theory into Practice,* 18 (3), 163-169.

Zhao, Y., Pugh, K. & Sheldon, S.(2002). Conditions for classroom technology innovations. *Teachers College Record,* 104(3), 482-515.